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DEPARTMENT OF AGRICULTURE.

Dept Report 26

ENCOURAGEMENT

TO THE

SORGHUM AND BEET SUGAR INDUSTRY.

A RECORD OF PRACTICAL EXPERIMENTS CONDUCTED UNDER THE
DIRECTION OF THE COMMISSIONER OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

ENCOURAGEMENT TO THE SORGHUM AND SUGAR-BEET INDUSTRY.

With a view to the encouragement of the production of sugar from sorghum, beets, and other sugar-producing plants, the Commissioner of Agriculture in June, 1882, prepared and caused to be forwarded to a large number of persons interested in the subject the following circular letter, which fully explains itself:

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., June 6, 1882.

To the manufacturers of sugar from sorghum, beets, and other sugar-producing plants in the United States:

Congress in the appropriation for this Department for the fiscal year commencing July 1, 1882, has provided for "experiments in the manufacture of sugar from sorghum, beets, and other sugar-producing plants."

In view of the experiments which have already been made at this Department, I have determined to institute the following plan for the coming season, in obedience to the act referred to:

Provision has been made for continuing the chemical analyses of sorghum at the laboratory of the Department, should this be deemed necessary, in order to add to the information already obtained by investigations not only here but also in the agricultural colleges of this country.

On assuming the duties of my office in 1881 I found 135 acres of sorghum, containing 52 varieties, which had been planted in Washington for the use of the Department. On being informed that the time had arrived for manufacturing sirup and sugar, I engaged the services of an expert in sugar-making who had been highly recommended for the position of superintendent, and operations were commenced on September 26 at the mill erected by my predecessor on the grounds. These operations were continued with slight interruptions until the latter part of October, at which time the supply of cane became exhausted. Forty-two acres of the crop were overtaken by frost before being sufficiently ripe for use, and this portion of the crop was so badly damaged as to be unfit for manufacture. The yield of cane per acre on the 93 acres gathered was 2½ tons; the number of gallons of sirup obtained was 2,977; and the number of pounds of sugar was 165. The expense of raising the cane was $6,589.45, and the expense of converting the cane into sirup and sugar was $1,667.59—an aggregate of $8,557.04.

The manufacture of sorghum at the Department therefore has been found to be so expensive and unsatisfactory, that the work can evidently be better conducted elsewhere. To repeat the experiment of last year would be unwise under any circumstances, and it is made doubly so by the impossibility of procuring the sorghum cane at any reasonable price in this neighborhood, after the discouraging crops of last year, and by the additional fact that the appropriation is not available until too late in the season for planting to begin.

While, therefore, such scientific investigation as is deemed necessary at this Department will be continued, the experiment of manufacturing can better be conducted by those who have thus far furnished us all the valuable information we have: and this work I refer to the manufacturers themselves, to whom I submit the following proposition:

Each manufacturer is requested to submit an account of his work to this Department. covering the following points, viz:

1. An accurate account of the number of acres of sorghum brought to his mill: the number of tons of cane manufactured; the yield of sorghum per acre; the mode of fertilizing; the time of planting; the time required for maturing the plant; and the value of the crop as food for cattle after the juice has been expressed.

2. The amount of sugar manufactured; the amount yielded per ton of cane; the quality of the sugar; the amount of sirup manufactured; the process of manufacturing; the machinery used; the success of the evaporator, the vacuum-pan, and the centrifugal in the work of manufacturing.

3. The number of hands employed in the mill; the cost of fuel: the cost of machinery; the wages paid for labor; and the price of sorghum at the mill if not raised by the manufacturer.

The returns when received will be submitted to a competent committee for examination, and in order to compensate the manufacturers for the work of making these returns, I propose to pay for the ten best returns the sum of $1,200 each—the decision to be made by the aforesaid committee. Each return must be sworn to before a competent officer.

SUGAR BEETS.

I have distributed to ninety persons a supply of the best sugar-beet seed which I could obtain; and I would request each person having received this seed to send to this Department a statement of the amount of land planted by him; the yield per acre the fertilizers used; the value of the crop in the market. I also request each person making this experiment to forward to this Department a sample of the crop for analysis. The directions for this will be issued hereafter. An accurate statement of the process of manufacturing beet sugar in this country is of great importance, and I propose to compensate the manufacturers for preparing such statement by the payment of the sum of $1,200 for each of the two best returns submitted to a committee, as in the case of sorghum.

OTHER SUGAR-PRODUCING PLANTS.

The promise of 1,000 pounds of corn-stalk sugar per acre, which was made in 1841, and has often been repeated with great confidence, both at the expense of the corn crop and in addition to it, not yet having been fulfilled in manufacture, the experiments not having been satisfactory, and the business not having been followed up, it is not deemed necessary to institute sugar-making experiments in this direction during the present year. The same may be said of many esculents which have been classed as sugar producers.

All proposals to enter upon this work for the Department must be laid before the Commissioner on or before August 1, 1882.

GEO. B. LORING.
Commissioner of Agriculture.

A large number of persons in different localities accepted the above invitation, and entered their names as competitors for the awards. Early in the season the Commissioner appointed as agent of the Department Mr. A. J. Decker, of Fond du Lac, Wis., and and requested him to visit, advise, and direct those who had undertaken these experiments. He also directed him to make a general tour of those States where sorghum was being grown, and where attempts were being made to manufacture its products on a commercial scale. Mr. Decker's report on his observations has been submitted, and the following facts are elicited therefrom:

SOIL.

Throughout the entire belt of successful sorghum growth the soil best adapted to the plant seems to be a warm loam or a sandy clay loam.

PLOWING.

There is but one case of fall plowing recorded, and no special advantage to the crop seems to be derived from it.

PLANTING.

Since the plant matures in from eighty to ninety days, varying with the varieties planted, the judgment of the cultivator must decide the date of planting. In the more northerly section the 1st of May, or as soon thereafter as the ground is sufficiently warm, is generally considered the best time, while in the southern sections planting in April is reported. No special method of planting seems to be required. When planted in hills, the hills are from three to three and a half feet apart one way, by two feet the other; and when planted in drills, the drills are usually one-half inch deep.

FERTILIZING.

Few trials with fertilizers are reported, and these few were made with lime, plaster, and ashes. A little lime in the hill is claimed by one raiser to be beneficial, producing a higher test in the Beaumé scale, but fertilizing the crop does not seem to be generally followed.

CULTIVATION.

It seems to be unanimously conceded that the sorghum crop should be cultivated the same as corn.

HARVESTING.

There are few exceptions to the practice of topping and stripping the cane in the field. The crop is then usually made up in bundles and hauled immediately to the mill.

HANDLING AT THE MILL.

But two methods are reported of handling the crop at the mill, where cane is stored before grinding. The one most generally in vogue is to pile the bundles of cane crosswise, while another method is to stand them upon end; and so far as reported one has no advantage over the other.

GRINDING.

Storage at the mill is necessary where the capacity is not equal to the demand upon it, but it seems to be generally conceded that the sorghum cane should be ground as soon as possible after cutting, and one manufacturer asserts that there is a deterioration in the juice equal to 5 per cent. if not crushed immediately after harvesting.

MILLS AND MACHINERY.

The apparatus for the extraction and manipulation of the juice of sorghum was found to differ both in design and size according to the fancy and need of the manufacturer. The mills are driven by horse or steam power, and are claimed to extract from 40 to 60 per cent. of the juice.

The defecators in use are in proportion to the capacity of the mill, the most common being made of galvanized iron, and having a dimension of four by six and two feet deep. The evaporators are mostly of the kind usually found in the market, being of a dimension of 4 by 16 feet, 2 feet deep. Very few finishers were found, but where they were in use the extra expense seemed to be justified by the production of a finer grade of sirup, usually commanding a better price. The vacuum pan and centrifugal were found only in those manufactories having a large capacity. The former were usually of a size ranging from 6 to 7 feet, and the latter from 18 inches to 3 feet.

COST OF OUTFIT.

The cost of the foregoing outfit cannot of course be stated, as it would vary greatly with the size and capacity demanded by the manufacturer. The cost of those mills, however, having the capacity for making large quantities of sirup and sugar, and which necessarily include besides the above other apparatus, such as bone filters, furnaces for preparing the charcoal, &c., may be stated to have been as follows: A mill having a capacity of 1,000 gallons of sirup every twenty-four hours contained a 7-foot vacuum pan, twelve large filters, with kiln for reburning the charcoal, and the necessary centrifugals, engine, boiler, storage tanks, and other apparatus for sirup-sugar production, cost $65,000. Another mill is reported upon, with a capacity less than the above (about 60,000 gallons a season), which cost something over $40,000.

PROCESSES.

The processes generally in vogue in the reduction of the juice seem to be about the same. After it is expressed at the mill it is conveyed to the defecator by mechanical means or by hand, and thence to the evaporator, where it is reduced to a sirup, and afterward stored for cooling, prior to crystallization or barreling for market. While the manipulation during this process differs somewhat, the general practice seems to be to treat the juice either while cold or during defecation with milk of lime, then neutralize the acidity to a degree indicated by the well-known litmus paper test, and reduce in the evaporator to 20° or 22° Baumé. Where finishers are used the general practice seems to be a still further reduction after evaporation, to from 35° to 44° Baumé. The practice of filtering the juice at the mill and before defecation is not general, but from the few cases reported it would seem to meet with good results. The filtration is made in one case through sulphur fumes, and in another through a common straw filter. There are those reported who use no lime or other correctives, and who do not practice filtration, but who produce a sirup claimed by them to meet the demand of their own local markets. There seem to be few who test the juice at the mill before manipulation, but from those who do make a practice of this it is learned that juice weighing from 7° to 8° Baumé will produce about 14 gallons of sirup per ton of cane, and that weighing from 10° to 12° will produce from 13 to 16 gallons per ton. In these several methods heat is applied either by direct fire or by steam through copper coils.

YIELD PER ACRE.

The actual weight of cane from an acre is not reported, and the estimated yield per acre varies from 8 to 20 tons. The greatest yield of sugar to the acre is reported at 971 pounds, and the greatest yield of sirup 200 gallons. At one large factory there is reported a yield of 792 pounds of sugar, valued at 8 cents per pound, and 112 gallons of sirup, valued at 40 cents per gallon, from an acre, indicating a net profit of $50.67. It should be understood, however, that this encouraging result was not obtained by the ordinary manufacturer, but by chemists who were skilled in the manipulation of the juice, and who were working with apparatus designed especially for the manufacture of sugar.

PURCHASE OF CANE.

There are a large number of manufacturers who make a business of purchasing the cane from farmers in adjacent localities, and for this the price seems to be from $2.50 to $4 per ton in some sections, and from $1.25 to $1.80 in others, and this price is said to include delivery at the mill.

DAILY PRODUCTION.

Perhaps a fair representation of the average production of a mill and apparatus costing $500 may be stated at 100 gallons, while there are reported other mills varying in capacity from 100 to 1,000 gallons daily.

PROFITS.

An estimate of the profit of raising an acre of sorghum has been furnished, and this profit, based upon an estimated production of 10 tons per acre, is placed at $10.25 for each acre. The varying price realized for sirup; the neglect to state whether board is or is not included in the average wages paid; whether or not the value of the owner's time, or that of the services of his team have been calculated; whether the fuel usually cut from the farm has been measured and accounted for, with other considerations, make it difficult to compute in an intelligent manner the profit of the manufacturer. There is one case reported which may fairly represent the average profit of a small mill: The capital invested was $500; the daily production was 100 gallons; the net profit was claimed to be $8.75 per day, the season lasting thirty-five days, and the sirup selling at 20 cents per gallon.

Other products are estimated at from 60 to 500 gallons per day, the former requiring three men and the latter ten men at wages varying from $1 to $1.50 per day, presumably including board.

COST OF PRODUCTION.

The cost of producing an acre of sorghum is stated at from $5.25 to $6.38 as it stands in the field, and delivered at the mill from $10 to $15. The cost of manufacturing a gallon of sirup, after the cane is stripped, is placed at from 5¾ to 6⅓ cents per galllon. Including the price of the cane, placed at $1.50 per ton, the cost of production per gallon is placed by a large manufacturer at 23 cents, including 4 cents per gallon for barreling.

PRICES RECEIVED FOR WORKING.

There are many factories whose owners work sorghum either on shares or at a stated price per gallon. When working on shares it seems to be usual to retain one-half of the product of sirup, and when working by the gallon, from 17 to 25 cents are charged.

FUEL.

In cases where wood alone is used, it is found that it usually takes one-half cord per each 100 gallons of sirup manufactured. Soft coal is also used at the rate of about 1,000 pounds to each 100 gallons manufactured. In addition to these articles used as fuel, there are found many cases where the bagasse is used as auxiliary to one or the other, and one case is reported where bagasse is used alone for running an ordinary evaporator. The price of coal is not given, and that for wood, when purchased, varies from $1 to $2.50 per cord. There is one report of the return to the land of the ashes of bagasse, but the result is not stated.

CRYSTALLIZATION.

It is well known that in the process of the manufacture of sugar from cane it is usual to so manipulate the juice in the vacuum pan that when it has been sufficiently reduced it is run directly into the centrifugal.

and the sugar is separated from the molasses immediately. This method does not seem to have been adopted in the treatment of sorghum juice. In the two manufactories where sugar was made last season were what are called "crystallizing rooms." In these the sirup, after treatment in the vacuum pan, is stored to await the process of granulation. This process seems to take from four to six days, and it seems to be necessary that the temperature of those rooms should be maintained at 90° Fahr. during this period.

USE OF SEED AND BY-PRODUCTS.

The value of the seed of sorghum is variously estimated. Many pronounce it equal to oats and other grain for the purpose of stock food, and believe that its value goes far towards defraying the cost of cultivating the crop. One raiser boils the seed, and states that when prepared this way and fed to hogs it is found that they do better than upon the same quantity of corn. The average production seems to be from 20 to 30 bushels per acre, and its value is stated in one locality to be 75 cents per bushel. Other by-products do not seem to be utilized, although it is stated in one section that the first skimmings have been found to make good fertilizers, and that the last are rich in sugar and make good vinegar.

SECURING OF SEED.

As has been stated, it seems to be the custom to top the cane in the field. The heads of seed are not reported to require any special care. The seed is secured by thrashing these heads in the usual manner. But one case is reported of the utilization of the head after thrashing. In this case it is asserted that they have been fed to cows, and that they prefer them to hay.

FAILURE OF CROP.

No special climatic condition is laid down which is considered as necessary to the production of this crop, but there are many failures reported of the crop last season either from drought or other causes.

PRODUCTION OF SUGAR.

Aside from the result reported from these large establishments that are equipped with elaborate machinery, and run by chemists and experts who fully understand the manipulation of the juice, there are no returns of sugar manufactured. The few efforts to make sugar in a small way have all failed, but investigation proves that there is little or no ambition in this direction, the smaller manufacturers contenting themselves with the returns from the simple manufacture of sirup and the supply of the local markets therewith.

PRICE OF SIRUPS.

There seems to be as great a variety of prices for the sirup as there is in the color and flavor of the article itself. This difference in quality does not seem to have found objection in the home market, especially when sold in small lots, but in every case such sirups have been declared unfit for the wholesale market. The prices obtained for this sirup range from 20 to 55 cents.

The Commissioner appointed as a committee to determine these awards Messrs. William Saunders, J. R. Dodge, and D. M. Nesbit.

AWARDS MADE BY THE COMMITTEE.

After a thorough examination of the reports submitted the committee made the following awards:

REPORT OF COMMITTEE ON AWARDS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., April 17, 1883.

SIR: The undersigned, appointed a committee to examine the reports of manufacturers of sorghum sugar and sirup, and also of beet sugar, with reference to the compensation offered by this Department for successful results, and the cost of the same, with instructive detailed description of processes by which the results were obtained, respectfully submit the following report:

That they have made a careful examination of the reports submitted to them, and find that manufacturers have fully complied with the requirements of the circular letter issued by this Department, and are therefore entitled to compensation, as follows:

ON SORGHUM SUGAR AND SIRUP.

A.—The Champaign Sugar Company, Champaign, Ill.
B.—Magnus Swenson, Madison, Wis.
C.—Paul Steck, 220 Fremont street, San Francisco, Cal.
D.—Nelson Maltby, Geneva, Ohio.
E.—Drummond Bros., Warrensburgh, Mo.
F.—A. J. Decker, Fond du Lac, Wis.
G.—Wm. Frazier.
H.—Jefferson Sugar Manufacturing Company, Jefferson, Ohio.
I.—Oak Hill Refining Company, Edwardsville, Ill.
J.—Clinton Bozarth, Cedar Falls, Iowa.

ON BEET SUGAR.

A.—Alvarado Factory, California.

B.—It was agreed that the Wilmington Beet Sugar Company would also have been entitled to compensation, but for the fact that their work was upon the products of 1881, and therefore did not come within the terms of the offer, which referred to the operations of last season, and were intended as an inducement, so far as facts would warrant, for future operations.

Very respectfully,

WM. SAUNDERS.
J. R. DODGE.
D. M. NESBIT.

HON. G. B. LORING,
Commissioner of Agriculture.

REPORTS OF PRODUCERS.

The following are the statements of the producers, manufacturers, &c., on which the committee based its awards:

REPORT OF CHAMPAIGN SUGAR AND GLUCOSE MANUFACTURING COMPANY.

CHAMPAIGN, ILL., *December* 1, 1882.

HON. GEORGE B. LORING,
Commissioner of Agriculture, Washington, D. C.:

DEAR SIR: In accordance with the requirements of your circular of the date of June 6, 1882, on the manufacture of sugar from sorghum, we beg to report that the Champaign Sugar and Glucose Manufacturing Company have kept accurate accounts of the results obtained by them up to this date, at which time the cold weather caused a suspension of operations, and we would respectfully submit the following report for your consideration under the propositions of the above-mentioned circular.

In order to get a correct idea of this season's work, so far as the sorghum industry is concerned, the condition of the weather as compared with other years is of material consideration.

The weather during this year, so far as planting, cultivation, maturing the crop, and the development of cane sugar in sorghum, in this section of the country, has been the most unfavorable of any year within our knowledge, and we are informed by those who have grown sorghum and broom-corn that this year has been the most unfavorable season for upwards of twenty years in this section for those crops.

A synopsis of the weather report of the Signal-Service station at this place is here given, showing a comparison of the growing seasons of this and last years:

Monthly mean temperature for year 1881.

	°F.
January	19.2
February	25.9
March	33.4
April	45.1
May	67.4
June	69.3
July	76.9
August	76.7
September	70.8
October	57.4
November	39.7
December	37.6
Annual mean	51.6

Monthly mean temperature for year 1882.

	°F.
January	28.7
February	39.4
March	41.8
April	51.7
May	55.8
June	69.1
July	70.1
August	70.7

September	
October	
Average for May, June, July, and August, 1881	72.4°
Average for May, June, July, and August, 1882	66.4°

Rainfall for months of May, June, July, and August.

	1881.	1882.
	Inches.	*Inches.*
May	3.63	8.55
June	4.71	9.93
July	1.07	2.44
August	.64	4.87

	Inches.
Total rainfall for those months in 1881	10.05
Total rainfall for those months in 1882	25.79

It will readily be seen that the average temperature during those four months was 6° in the year 1881 above what it was in the year 1882, and the rainfall during those months in 1882 was more than 15 inches over what it was in the year 1881. There was too much rainfall in the year 1882 during the working months for the proper cultivation of the canes, and the temperature averaged too low for the proper development of saccharine matter.

The following table will show the comparative value of the same varieties of cane, in the same stage of maturity, this year and last year, the same having been analyzed by us. Variety of cane, Early Amber.

	1881.	1882.
Specific gravity of juice	1.070	1.060
Cane sugar	12.08	8.20
Grape sugar	2.47	3.66

We began planting sorghum the first week in May, and finished planting on the 23d day of June. The delay in planting was caused by the unusual amount of rainfall last spring. The land upon which the sorghum was grown was rich prairie soil. The most of the land had been planted in broom-corn the previous season, and no fertilizers whatever were employed.

In regard to the time required for the maturity of the crop the different fields varied considerably. The cane planted later in the season, when the conditions for growth were more favorable, developed much more rapidly than that planted earlier.

The following table shows the time required by the two varieties of sorghum raised by the company:

Variety of sorghum.	Date of planting.	Date of maturing.	Number of days required for maturing.
Early Amber	May 2	September 21	140
Do	May 9	do	132
Do	May 16	do	125
Do	May 26	do	115
Do	June 1	September 25	115
Do	June 15	October 25	130
Early Orange	April 28	do	177
Do	May 23	November 1	158

The average time for maturing Early Amber in this section of the country in favorable seasons is one hundred days, and Early Orange one hundred and twenty-five days.

Owing to the lateness of the season, one field of Orange cane was worked up before it was ripe, and another field of Orange was cut and shocked. The former and the greater portion of the latter was worked for sirup only.

Number of acres of sorghum brought to the mill	244.59
Number of tons of cane manufactured	2,882.75
Yield of sorghum cane per acre, the cane being stripped and topped, tons	9.33

THE VALUE OF THE CROP AFTER THE JUICE HAS BEEN EXPRESSED AS A FOOD FOR CATTLE.

The bagasse was carted as it fell from the carrier to an open field, accessible to the town cows. About one hundred of them fed daily upon that which was fresh. They ate of it greedily, and gained flesh quite rapidly, while the bagasse was fresh, but after the grinding season was over and the bagasse got dry they declined to eat of it. We are of the opinion that the fresh bagasse may profitably be used as a food for cattle, but that it is not of sufficient value to justify its being saved for that purpose.

Number of tons of cane worked for sugar	1,723.99
Number of acres of cane worked for sugar	185.8
Number of pounds of sugar manufactured (firsts only were made)	86,603
Number of pounds of sugar per ton	50.3
Number of pounds of sugar per acre	465½

The quality of the sugar as graded by dealers is Yellow C. The average polarization of several samples of the sugar was 97.4 per cent. The sugar sold at the factory by the barrel at 8 to 9 cents per pound.

Number of gallons of molasses and sirup	25,137

The composition of the molasses is as follows:

	Per cent.
Cane sugar	36.20
Invert sugar	20.17

The large porportion of cane sugar remaining in the molasses would warrant its being worked for seconds, if the company had buildings which could be kept sufficiently warm.

PROCESS OF MANUFACTURE.

The cane is run through the first mill, and its bagasse is saturated with hot water, and then run through the second mill. The juice from both mills flows into the same pan or tank, and is from there pumped into a juice tank in the top of the building: from that tank it flows into another juice tank, and from there is drawn into the defecators as desired. The expressed juice is treated in the defecators with milk of lime until it shows a neutral reaction, this being determined with litmus paper.

After neutralization the liquor is heated to boiling and skimmed. After skimming the liquor is allowed to settle for half an hour or more. At the end of this time the liquor becomes clear, and a sediment collects at the bottom of the defecators, which is prevented from running when the liquor is drawn off by placing an open plug, 4 or 5 inches long, in the outlet at the bottom of the defecators. After the juice has settled it is drawn off into an evaporator, where it is evaporated to a density of 25° Baumé. The semi-sirup thus obtained is run into settling tanks.

A sediment of feculent matter collects at the bottom of these tanks on standing, and is separated from the semi-sirup by means of open plugs as used in the defecators. From the settling tanks the semi-sirup is run into a reservoir or tank, and from there is filtered through bone coal. It is then conveyed to the vacuum pan, and in it is evaporated to malada or mush sugar. It is then drawn off into crystallizing cars or wagons, and swung out as soon as possible with the centrifugal.

The molasses, swung out by means of the centrifugal, is again put in the vacuum pan and brought to the desired density of 40° Baumé.

The office of lime in the raw juice is twofold. First, it aids in defecating the juice; second, it neutralizes the acids normally present, and prevents the invertion of the cane sugar, which would otherwise take place on heating.

The chief office of the bone-black is to free the raw semi-sirup from the nitrogenous and gummy matter still in solution. By this means the crystallization of the sugar is readily and surely accomplished in the vacuum pan, and the sugar and molasses thus obtained are of a superior quality and entirely free from objectionable sorghum taste and odor.

The machinery used was as follows:

One engine, 90 horse-power.

Two boilers, 90 horse-power each.

One mill, used as first mill, Cuba No. 2, made by Geo. L. Squier & Bro., Buffalo. N. Y., with cane-carrier 60 feet in length.

One mill, used as second mill, made by Atlantic Engine Works, Brooklyn, N. Y., with which was used Messrs. Squier's rubber springe, with his consent. Both mills are three-roller mills; rolls, 4 feet in length and 2 feet in diameter.

One juice pan and pump.

Two juice tanks in top of building, of a capacity of 1,500 gallons each.

Four defecators, 3 feet deep, and a capacity of 661 gallons each.

One defecator, 3 feet deep, capacity of 1,363 gallons.

Two evaporators, 3 feet deep and 8 feet in diameter.

All defecators and evaporators are supplied with copper coils for heating. and all heating and boiling is done with steam.

Two settling tanks of the capacity of 450 gallons.

One reservoir over bone filters of a capacity of 600 gallons.

Four bone-coal filters, 2 feet in diameter and 12 feet long.

One liquor tank, under filters, of 1,000 gallons capacity.

One liquor tank, under vacuum-pan condenser, of capacity of 4,000 gallons.

One water tank for boilers, capacity 2,000 gallons.

One vacuum pan 7 feet in diameter, three copper coils, and Blake pump.

One water pump for cold water.

One pump to feed boilers.

One semi-sirup pump.

Fifty crystallizing wagons, capacity of 120 gallons each.

One mixer.

One Weston centrifugal, 36 inches in diameter.

One molasses tank of 1,000 gallons capacity.

One sirup tank of 700 gallons capacity.

One sirup tank of 1,900 gallons capacity.

One bone coal kiln with twelve retorts.

One Fairbanks scales for weighing sugar.

One Fairbanks scales for weighing cane.

Two carts for hauling the bagasse away.

The plant is not well adjusted, and it will require the following additional machine to make the plant complete for the working up of 1,000 acres of cane in a season of about seventy days:

Two boilers, 90 horse-power each.

Eight filters, 2 feet diameter each and 12 feet long.

Three centrifugals, 30 inches in diameter.

THE SUCCESS OF THE EVAPORATOR.

Under a pressure of 70 pounds of steam the evaporators reduced 600 gallons of juice to semi-sirup of a consistency of 25° Baumé in forty minutes. Unquestionably, steam evaporation is the best system, and shallow evaporators will enable the operator to produce a lighter colored liquor than he can make with a deep one.

THE VACUUM PAN.

The success of the vacuum pan was all that could be desired with us. The sugar readily crystallized, and the crystals were built up in the pan large enough to be "purged" by the time the "strike" was made. We consider the vacuum pan an indispensable part of a sugar plant—

1st. In order that the crystallization of the sugar may be rapid.

2d. To insure a more thorough crystallization.

3d. To evade the darkening of the sugar and molasses, which an open train causes.

4th. To economize in the use of steam.

5th. To accelerate the evaporation.

During our season's work in running the vacuum pan for sugar we did not fail at any time to produce crystals therein of proper quantity and desirable size.

THE CENTRIFUGAL.

Without the centrifugal the separation of the molasses from the sugar in sorghum would be attended with great difficulty, especially if the melada is thick enough to insure a profitable amount of sugar. But by the process used by us at Champaign, we find no considerable difficulty in separating the sugar from the molasses by the use of the centrifugal, during the time it was warm enough to work. In a well-heated room the centrifugal would do its work satisfactorily at all seasons of the year.

We consider the centrifugal indispensable in the manufacture of sugar from sorghum, because when the malada is of the most desirable and profitable consistency the drainage of it would be almost, if not quite, impossible in any reasonable time.

The number of hands employed in and at the mill.

At cane-carrier	1
At feeder	1
At juice tank (boy)	1
At bagasse carrier (boy)	1
Carting bagasse (boys)	2
Engineer	1
Assistant engineers	2
Firemen	4
At defecators	2
At evaporators	1
At vacuum pan	1
At filters	2
At mixer	2
At centrifugal	2
Cleaner	1
Weigher	1
Superintendent	1
Total	26

This statement has included the day and night force.

The cost of fuel was the sum of $312; the cost of machinery was the sum of $15,814.65

Wages paid for labor.

For raising, cultivating 184 acres, and harvesting 221½ acres (including cutting, stripping, topping, and hauling)	$3,637 36
Wages paid employés employed at the factory	2,040 68
Total amount paid for wages	5,678 04

Price paid for sorghum at the mill, which was not raised by the company.

	Per ton.
Stripped and topped	$2 50
Stripped but not topped	2 00

For the purpose of ascertaining the amount of sugar in the best cane of this year, we selected one field of Early Orange cane of 12½ acres, raised by John G. Clark, and kept all the products separate from the rest. This was the best field of cane which came to the mill this season:

Composition of the juice.

Specific gravity, 1,060.

Cane sugar	per cent	10.17
Grape sugar	do	2.48
Number of acres in field		12½
Tons of cane (stripped and topped)		151
Tons of cane per acre		12.1
Total amount of juice, in gallons		20,939
Per cent. of juice		61.20
Pounds of sugar		9,600
Gallons of molasses		1,450
Pounds of sugar, per acre		768
Gallons of molasses		116

Value of product.

Sugar, 9,600 pounds, at 8½ cents	$816 00
Molasses, 1,450 gallons, at 40 cents	580 00
Total	1,396 00

Cost of cane and expenses of manufacture.

151 tons of cane, at $2.50	$377 50
4 firemen, two days and nights	14 40
1 engineer, two days	4 00
1 assistant engineer, two days	4 00
1 assistant engineer, two nights	4 00
1 feeder, two days	3 30
1 weigher, two days	3 00
1 man, cane carrier, two days	3 00
2 boys, juice pan and bagasse, two days	3 00
3 days, defecator's work	4 50
1 evaporator, two days	3 00
1 man at filler, two days	2 50
6 days' work at mixer	7 50
6 days' work at centrifugal	9 00

1 superintendent, two days	$6 00
Vacuum-pan work, 1 day	3 00
2 cart boys and horses, two days	6 00
1 man, barreling, two days	2 50
Burning bone coal, half day	75
Fuel for two days	18 50
Wear on machinery for one-thirtieth of running season, estimating wear at 10 per cent. for season	52 71
Interest on capital stock of $25,000, at 8 cents for running season, counting two days one-thirtieth of season or year	66 67
35 sugar barrels, at 48 cents per barrel	16 80
28 molasses barrels, at $1.35 per barrel	37 80
Total	653 43

Recapitulation.

Total value of product	1,396 00
Cost of cane and expense of manufacture	653 43
Profits on the field	742 57
Gross value of product for 1 ton	9 24½
Gross value of product for 1 acre	111 86
Profit on 1 ton	4 91
Profit on 1 acre	59 46

With an increase of two boilers, eight filters, and three centrifugals, the whole 151 tons of cane could have been worked up in one day and night, and without, as we can see, any additional expense to the company for the time actually employed. This would make a very material saving on the items of labor, depreciation, and wear of machinery.

Having given above the cost of machinery, we think that probably you would like to know the total cost of the plant, and we therefore give the same:

Buildings, labor on same; boiler-house and labor on same; bone kiln and labor on same; scales, scale house, and labor on same; wells, and labor in setting up machinery	$11,108 00
Cost of machinery	15,814 65
Cost of plant	26,922 65

We beg to call the attention of your Department to some of the principal difficulties encountered during the year, and we think, in justice to your Department and ourselves, they should be fairly considered in determining the probable value of this industry to our great and growing country.

The company were unfortunate in not having a crystallizing room, capable of being heated to the proper temperature for the best results in crystallization, and the subsequent purging of the sugar. The room was so cold that the melada was too stiff to arrange itself evenly in the centrifugal without the addition of warm water in the mixer, and even then it was often found impossible to purge without washing with warm water. We took the trouble to make experiments to see how much or what proportion of sugar was being washed down with and into the molasses by reason of the cold. It was done by taking a certain weight of melada, 120 pounds, which was carefully warmed and then swung out. The yield was 56 pounds of dry sugar. The same amount of melada from the same car was swung in the usual way, and the yield was 38 pounds of dry sugar, or a loss of 18 pounds of sugar in a purge, by reason of the cold. We had but a few days of favorable weather, and the results from it compared favorably with the above experiment.

Upon that basis we find that there was uselessly washed away 27,799 pounds o sugar. Add sugar obtained, 86,603.

With a suitable crystallizing room, kept at a temperature of from 98° to 100°, the sugar product would have amounted to 114,402 pounds. This would have made the yield per ton of 66.3 pounds. Yield per acre, 615.7 pounds.

This sugar was actually made, and was lost in separation, by reason only of the fact that it could not be kept at the proper temperature. This difficulty can be overcome by having a crystallizing room, and having it kept properly heated.

In the next place *sorgo* requires hot summer weather for its proper development. As shown in our report, the average temperature during the part of the past season fell far below the usual summer temperature in this section, and was an average of 6° below the average of the same months of last year.

The effect upon the development of sugar will best be seen by comparing an average of analyses made last year with those of the season just ended. The cane in each instance was of the same stage of maturity.

	Per cent.
Average analyses, year 1881, cane sugar	12. 20
Average analyses, year 1882, cane sugar	9. 24

It will thus be seen, that, all other things being equal, the yield of sugar obtained this year would, in ordinary seasons, be increased one-third. And so we give the following statement to be the best of our knowledge and judgement, as an average yield of sugar per ton and per acre in ordinary seasons.

In ordinary seasons:

	Pounds.
Yield per ton	88. 4
Yield per acre	820. 9

And this statement is made upon the basis of 9½ tons per acre of stripped and topped cane, for *firsts* only.

We were unable to make seconds, and are not prepared to say how much sugar might be obtained from the molasses.

In conclusion we would recommend—

1. The seed should be planted as early as possible, in order to have as long a working season as possible. We would recommend planting Early Amber for about one-half of the crop, and for the rest of the crop late maturing varieties should be planted, as they produce larger stalks, a greater tonnage per acre, and consequently more sugar and sirup per acre. Such varieties as Link's Hybrid, Early Orange, and Liberian.
2. The proper time for cutting cane can best be determined by analyses. In ordinary seasons, and in sections of the country where hot summer weather prevails, the development of the cane holds pace with the formation of the seed, and cane sugar reaches its maximum when the seed is in hardening dough. This season, however, we found that the percentage of cane sugar increased for some time after this stage.
3. The manufacture of sugar can be properly conducted only with the best apparatus, and on a scale which would justify the erection of steam sugar works, with vacuum pan, steam defecators, and steam evaporators. A crop of 600 to 1,000 acres would justify the erection of such a plant, and the employment of a competent chemist to superintend the work.

HENRY A. WEBER,
MELVILLE A. SCOVELL.

REPORT OF MANGUS SWENSON.

Hon. Geo. B. Loring,
United States Commissioner of Agriculture :

I hereby respectfully submit the following report :

Three plots of cane, of 1¼, 2, and 3.6 acres, respectively, were worked, the aggregate being 6.85 acres. The number of tons of stripped and topped stalks was as follows

	Plot A, 1¼ acres.	Plot B, 2 acres.	Plot C. 3.6 acres.
	Tons.	*Tons.*	*Tons.*
Yield of plot in tons	8.55	14.5	37.6
Yield per acre in tons	6.8	7.25	10.4

Average yield of three plots per acre, 8.1 tons. Total quantity of cane worked, 60.67 tons. Plot A was used for experiments with different fertilizers. The plot was divided in divisions, each containing one-twentieth of an acre. These divisions were separated from each other by the planting of guard rows, and on these no fertilizers were used. The land was a sandy loam, gently sloping toward the south,

The following table gives the result of the use of fertilizers :

FERTILIZERS.

[Obtained at the Connecticut experiment station. See report Connecticut board of agriculture, 1880, p. 63.]

	Nitrogen on plot one-twentieth acre.	Per cent. of cane sugar.	Per cent. of glucose.	Weight of cane.
	Lbs.			*Lbs.*
No manure	....	10.91	2.80	828
2,339 pounds barn-yard manure	....	10.19	2.77	864
Nitrogen mixture [*]	1.2	10.57	2.77	796
Superphosphate (15 pounds)	....	10.54	2.80	762
Chloride of potasium (7½ pounds)	....	10.95	7.28	910
Nitrate of soda (7½ pounds), superphosphate (15 pounds)	1.2	10.77	2.56	776
Nitrate of soda (7½ pounds), chloride of potassium (7½ pounds)	1.2	10.18	2.78	856
Superphosphate (15 pounds), chloride of potassium (7½ pounds)	....	10.63	2.89	778
Barn-yard mixture	....	10.87	2.85	578
No manure	....	11.63	2.85	616
Mixed minerals and nitrogen[†]	1.2	11.34	2.76	472
Mixed minerals and two-thirds nitrogen	.8	10.92	2.80	578
Mixed minerals and one-third nitrogen	.4	10.41	2.94	548
Mixed minerals and one-sixth nitrogen	.2	10.10	2.86	560
Mixed minerals and one-twelfth nitrogen	.1	11.59	2.90	618
Mixed minerals	....	10.47	2.87	590

[*] The nitrogen mixture consisted of nitrate of sodium, sulphate of ammonium, and dried blood in equal parts, per acre.

[†] The mixed minerals consisted of 300 pounds superphosphate and 150 pounds of chloride of potassium per acre.

The cane from these divisions was cut and stripped and brought in separate loads to mill where it was ground and the juice from each was defecated separately, a sample from the defecated juice being used for analysis. There was no difference in the yield of juice, but some of them contained a large amount of albuminoid matter.

Especially was this the case with No. 2, where 2,339 pounds barn-yard manure was used. This juice contained so much albuminoid matter that a good defecation could not be made, and about half the entire lot had to be thrown away. Nearly all of the defecated juices from the manured sections were darker than those from the unmanured.

The sirup from the entire fertilized plot was mixed, and the sugar separated from it was also darker in color than that from the other plots.

TIME OF PLANTING.

The cane was planted between the 15th and 25th of May. Some that was planted previously was frozen and was replanted.

TIME REQUIRED FOR MATURING.

Owing to the very backward season the growth of the cane was exceedingly slow. By the 1st of October about one-half of the heads were becoming hard, and it was not until the middle of October that the cane could be said to be ripe. From my last year's record I find that the cane grown on the same plot ripened fully five weeks earlier than this year, though the cane was planted about the same time. The time required for the maturing of the Early Amber cane this year was about one hundred and forty-five days.

VALUE AS FODDER.

No feeding experiments were conducted with the bagasse. The rapidity with which it ferments is certainly a great drawback to its being used as fodder.

AMOUNT OF SUGAR AND SIRUP MANUFACTURED.

The following table gives the yield of the three plots:

	Plot C, 3⅗ acres.	Plot B, 2 acres.	Plot A, 1¼ acres.
Total weight of stripped cane .... pounds..	75, 262	28, 974	17, 112
Per cent. of juice expressed	65	47	47
Per cent. of cane sugar in juice	9. 89	12. 10	11. 20
Per cent. of glucose in juice	3. 95	2. 86	2. 76
Weight of cane sugar (firsts) .... pounds..	2, 116½	1, 008	594
Gallons of molasses	409	101	58
Yield of cane per ton:			
Sugar .... pounds..	56. 3	70	69
Molasses .... gallons..	10. ⅘	7	6⅘

Three acres of the cane from the 3⅗ acre plot was rolled through the five roller mill. It was the first piece worked, and the cane was very immature, fully one-third of the heads being still in milk. This accounts for the small amount of sugar and large quantity of molasses. The molasses has all been reboiled and is heavily crystallized, but, as yet, no sugar from it has been separated.

QUALITY OF SUGAR.

The sugar was uniformly good. The crystals were large, and in every respect equal to those from the Southern cane.

PROCESS OF MANUFACTURING.

The cane was brought to the mill and pressed as soon as possible after being cut. The fact that the cane deteriorates very rapidly after being cut was proven conclusively last year, and again this year. Several tons of cane from Plot C were piled up by the mill from Friday a. m., October 13, till Monday p. m., October 16. The following shows the change which took place:

	Cane sugar.	Glucose.
Cane on October 13	10. 59	2. 85
Cane on October 16	9. 50	5. 00

The juice was strained through a straw filter, which consisted merely of a keg, with a perforated bottom filled with straw. The straw was changed when it began to clog. All the coarse particles were in this way readily removed. The juice was pumped into the defecators by a steam jet pump, which I consider admirably adapted for such work. The steam from the jet heated the juice slightly lukewarm.

DEFECATION.

Sufficient lime was added to the juice to give it a slight alkaline reaction. This can be ascertained by litmus paper, and I think more readily by the appearance of the juice. While the juice is acid it will have a uniformly greenish appearance, but as soon as it becomes alkaline, flakes of coagulated vegetable matter will appear. It is easily seen by taking out a small quantity of juice in a glass beaker, when the flakes of vegetable matter will be seen to settle. If too much lime had been used, more fresh juice was added, until the proper point was reached. It is preferable to have the juice but slightly alkaline, but alkalinity is essential to a good defecation, since much of the vegetable matter is not coagulable except through the combined effect of alkalinity and heat.

A dense precipitate of albuminoid matter was formed in sirup which was evaporated in an open pan, to 25° B. if the juice did not have an alkaline reaction when defecated. After the lime was added, the juice was raised to the boiling-point as quickly as possible. The heating was stopped as soon as the scum began to swell and break on the surface. After three or four minutes the scum was removed and it was again heated, this time to a quiet ebullition. The steam was again shut off, and the scum removed as before. This was repeated two or three times and the result was a very clear juice almost free from sediment.

EVAPORATION.

The defecated juice was then run into an open evaporating pan, where the juice was evaporated to about 20° B. From the open pan it was drawn into the vacuum pan, and evaporated to a dense sirup of about 42° B., thence into wooden crystallizing vats lined with tin, each holding about 50 gallons. In about three or four days it was ready to separate. The whole process was hurried as much as possible.

The interval from the time that the cane was passed through the mill until the sirup from it was drawn from the vacuum pan, averaged about three hours.

MACHINERY USED.

The machinery used consisted of one 10 and one 8 horse-power boiler, one 10 horse-power engine, one five-roller mill; 1-inch jet pump; two defecators, 3½ feet high and 2½ feet square; one evaporator 6 by 3 feet, and one 4 by 2 feet, all heated with iron pipe coils; one vacuum pan, 30 inches in diameter; and one centrifugal machine, 30 inches in diameter.

Much juice is lost on account of the inefficiency of our ordinary three-roller mills. In this state the average amount of juice expressed will probably not exceed 40 to 45 per cent. of the weight of stalks, or about one-half the juice remains in the bagasse.

An attempt was made to construct a mill that would press the cane more perfectly. The mill was made with five rollers, so as to subject the cane to four gradually increasing pressures, the last pressure being double that of the first three; the rest was crushed with a three-roller mill.

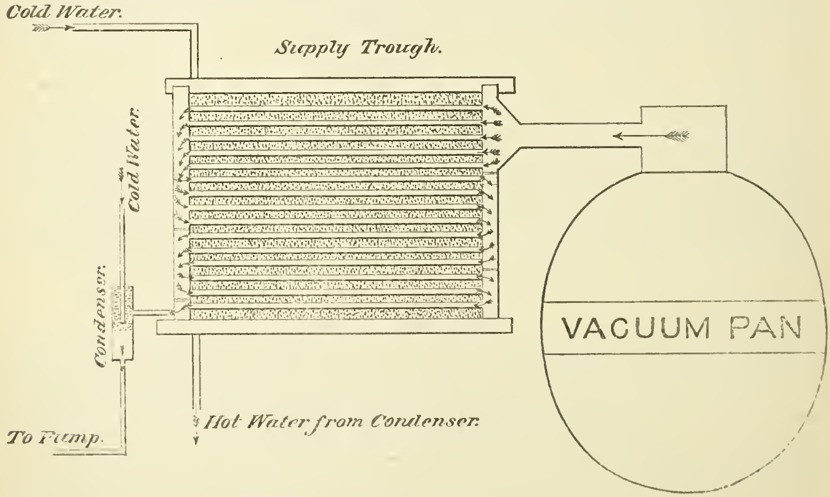
The per cent. of juice obtained was 69½ per cent. The advantage gained is threefold: 1st, a large percentage of juice; 2d, the bagasse is left comparatively dry for fuel; 3d, the bagasse was so disintegrated, being broken up into small pieces, that it was much more easily handled, and in a condition to be more easily dried. Two three-roller mills were also tried with the same kind of cane, one giving 47 and one 51 per cent. of juice.

The heating coils in the defecators and open evaporators were made of iron gas pipe, this being also used by all the small manufacturers in this State.

There are serious objections against the use of iron pipes for such a purpose. I found it impossible, even with 100 pounds of steam, to make the juice boil vigorously enough to keep it from boiling over. The result was that only a small amount of steam could be turned on, making the process of evaporation very tedious and slow, as well as detrimental to the sugar in the sirup. This trouble is further increased by the tendency of the pipes to get covered with a film or crust of non-conducting material, the rough surface of the iron pipes making it adhere very firmly. This was especially the case with the coils in the defecators. Copper, on the other hand, on account of its smooth surface, will keep perfectly clean, and being also an excellent conductor of heat, the evaporation will proceed much more rapidly. A full head of steam may be used without the danger of boiling over, the boiling in this case taking place so rapidly as to break the scum.

WORKING OF VACUUM PAN.

To avoid using a large amount of condensing water, and also to supply the boiler with warm water, a series of copper tubes were placed between the vacuum pan and the condenser proper. The steam was made to pass from the vacuum into these tubes where it was mostly condensed by a stream of cold water running on the outside of the pipes. If any steam remained it was condensed by a jet of cold water on reaching the condenser. The following sketch shows the arrangement.



A better arrangement would be to place the coil in a tight box and force the cold water in through the bottom and let the warm water flow out at the top. By using cane juice for this purpose, I think quite a saving in fuel could be realized. As the juice could be quickly heated to about 140° F. it would moreover greatly diminish the quantity of condensed water, which has to be pumped out again against about five-sixths the pressure of the atmosphere. After the sirup had been reduced to about 25° B. in the open pan it was drawn into the vacuum pan by means of a pipe, which projected from the latter into the open pan. During this time the vacuum pump was of course working in order to draw the sirup into the vacuum pan.

Each charge was sufficient to nearly half fill the vacuum pan. As soon as the open pan was emptied the valve in the supply pipe was closed. Steam was allowed to enter the heating coils, and as soon as the copper pipe condenser had become quite warm, *i. e.*, filled with steam, a stream of cold water was caused to flow on the outside of the pipes. The steam was at once condensed and the mercury suddenly began to rise, the boiling taking place at the same time much more rapidly. Steam was turned on as long as the mercury column remained stationary at about 20 inches.

The boiling was continued until the proper density was reached. This point can be quite easily determined by watching the mercury column, which will invariably begin to rise quite suddenly as soon as the water is reduced to 18 or 20 per cent. Each charge was reduced separately to a thick sirup.

I do not believe that the average juice from the sorghum cane is of sufficient purity to allow of its being boiled to grain in the vacuum pan. I obtained a much coarser sugar by allowing the crystallization to take place in small tanks, and it was consequently much more easily separated.

CENTRIFUGAL.

The centrifugal machine was one of German (Fescas) make. The basket was 30 inches in diameter, and 12 inches high. From 30 to 40 pounds was separated at each charge. The speed did not exceed 800 revolutions per minute, and the time for each charge was from five to twenty minutes. It was found very useful to steam the basket, after the sugar had been removed in order to free the wire screen from any hardened sirup which had accumulated there.

The number of hands employed was one at the mill at $1.50 per day, one fireman at $2, and two men in the factory each at $2 for twelve hours work. Cost of fuel, $6.50 per ton for soft coal. The total cost of machinery—not including the 10 horse-power boiler and engine, which was borrowed—was about $12. Everything but the boiler and centrifugal was made by myself or by students in the university machine shop. The cane was raised on the university farm.

Respectfully,

MANGUS SWENSON,
Chemist Agricultural Department, University of Wisconsin.

MADISON, WIS., *December* 8, 1882.

Subscribed and sworn to before me this 9th day of December, A. D. 1882.

A. B. MORRIS,
Notary Public, Dane County, Wisconsin.

REPORT OF PAUL STECK.

The United States Department of Agriculture, Washington, D. C.:

On receipt of circular issued by the United States Department of Agriculture; to the manufacturers of sugar from sorghum, beets, and other sugar-producing plants, I herewith submit a brief report of my experiments in the manufacturing of sugar and sirup from sorghum. I have rented a beet-sugar factory with a capacity of working 50 tons of sorghum in twenty-four hours.

MACHINERY USED FOR MANUFACTURING.

One set of three rollers, 20 inches in diameter by 36 inches long, with a 40 horse-power double cylinder engine.

Four clarifiers, capacity 500 gallons each.

Three filter presses.

Six bone coal filters, dimensions 3 feet in diameter by 25 feet long.

One double effect evaporator (evaporated under a vacuum).

A vacuum pan 5 feet in diameter.

Three centrifugals and necessary engines and pumps.

PROCESS OF MANUFACTURING.

The juice, after being extracted from the sorghum (about 400 gallons), was pumped into the clarifiers, using, to the average clarifiers, one bucket of lime milk, just strong enough to turn litmus paper light blue, first heating the juice to 120° F., then mixing with the lime milk, gradually heating till the scum forms on the surface, which indicates that the juice is clarified; shutting off then the steam. From here the juice was run into a monte-jus, which then was forced by steam through the filter presses, separating the dirt from the clarifiers, afterwards running the juice through the bone coal filters for discoloration and purifying. From here it was run in the double-effect evaporators, evaporated by a 24-inch vacuum to 21° density.

If clear enough it is taken to the vacuum pan; if not, it is once more passed through the bone-coal filters into the vacuum pan, and is boiled down for sirup to a density of 48° B., and for sugar to sugar proof.

From the vacuum pan it was let into tanks for crystallization, then taken to the centrifugals to separate the molasses from the sugar.

THE PLANTING OF SORGHUM.

I planted 400 acres of sorghum, Hondurus and Early Amber varieties, during the latter part of May and June, and early part of July, along the Sacramento River. The reason why I planted so late was on account of the land being flooded, and was compelled to wait until the soil was in a fit condition to plant the seed. The cane planted in May and June ripened, while that planted in July was so late that the frost nipped it before it could mature. I was obliged to sell that crop for fodder. The cane which was planted in May and June was cut in September.

The seed was planted with a corn-planter, averaging 15 acres per day, working a man, a boy, and two horses. As soon as the cane grew to a height of 6 inches it was cultivated and thinned out, leaving about five stalks to a hill, the hills being 3 feet apart.

During its growth it was well cultivated and suckered, taking about four months to be well matured, and contained the highest percentage of sugar. The first analysis was made in the middle of July, and contained 3 per cent. sugar; the second, in August, 6 per cent.; the latter part of August, 8 per cent.; and in September 10 per cent.; when cut, contained 16 per cent. All these analyses were made by means of the polariscope.

The refuse cane, after coming from the mill, was laid in the field to dry, and used for fuel.

The cane was raised along the Sacramento River by different farmers at $2.50 per ton delivered on the levee, then transported on steamer to mill at $1 per ton, making $3.50 per ton delivered to the mill. The average yield was 15 tons per acre, and grew to a height of from 10 to 12 feet, some stalks weighing as much as 3 pounds.

The factory was rented by me at $4,000 a season. I employed thirty men, average wages $2 per day, working day and night. I worked from 40 to 45 tons of sorghum per day, making cost for cane $150 per day; expense for labor, $60; oil and lime, $5;

fuel, using screenings, 5 tons a day at a cost of $4 per ton, making $20; also using the refuse cane, making a total of $235.50 per day.

I manufactured from 600 to 650 gallons of sirup per day; average market price 50 cents per gallon. The reason why I could not manufacture sugar in quantity was on account of the juice not crystallizing in the vacuum pan, as cane sugar should do, so I was compelled to let the sirup run into tanks for crystallization. The sirup which I manufactured from this sorghum was superior to any in the market, both in color and taste. The time required in making the alterations necessary and the putting in of large tanks, and other changes which I would have to make, was too short, so I converted the crop into sirup, as above stated. The sorghum sirup has a very slow crystallization, and the room in which it is kept should have a temperature of not less than 105°. It is a very important point in manufacturing sugar from sorghum not to bring the juice to boiling-point, as it checks the crystallization; therefore it should always be evaporated in vacuum pans (what we call single, double, and triple effect), and also the cane brought to the mill should be manufactured into sugar or sirup within twelve to fifteen hours, as the longer it is exposed to air the more the sucrose will turn to glucose. There should not be more cane cut in the field than can be worked at the mill each day.

The cane should be harvested as soon as the percentage of sugar ceases, and the seed planted at intervals of a week or more, not planting all the seed at once. I cannot state accurately how many acres of cane were delivered to the mill, the farmers not delivering all I contracted for, and buying by the ton as above stated; also that the cane planted in July was sold for fodder, as it was frost-bitten. The seed makes an excellent fodder, being equal to barley or oats. During my run last season I fed my horses entirely on hay and seed.

The machinery, including boilers for the manufacturing and refining sugar from sorghum, will cost from $20,000 to $25,000, with a capacity of working 50 tons of sorghum per day. I was obliged to close the factory this season, as most of the surrounding factory land is still flooded, and the expense is too great for me to plant the cane away from the factory. My intention next year is to manufacture sugar from sorghum, knowing the exact process necessary for its manufacture, also the land suitable for the planting of sorghum. I have the drawings of a factory for the manufacture of cane sugar, with the latest machinery used, and if the Department would like a copy of said drawings would gladly forward the same.

Hoping for a favorable consideration of my report,

I remain, respectfully,

PAUL STECK.

1220 FREMONT STREET, *San Francisco.*

SUMMARY.

I.

Number of acres of sorghum brought to the mill: 300.

Number of tons of cane manufactured: 3,600.

The yield of sorghum per acre: 15 tons.

The mode of fertilizing: None; planting in natural earth.

The time of planting: May, June, and July.

The time required for maturing the plant: Four months.

Value of crop as food for cattle after the juice has been expressed: None; used for fuel.

II.

The amount of sugar manufactured: About 5 tons.

The amount yielded per ton of cane: About 80 to 90 pounds.

The quality of the sugar: Light yellow color; polariscope, 86 per cent.

The amount of sirup manufactured: 54,000 gallons.

The process of manufacturing: Stated in manuscript.

The machinery used: Mentioned,

The success of the evaporator: *Open evaporator will not do; the sugar must be boiled in a vacuum pan.*

The vacuum pan and centrifugals in manufacturing sugar: Good.

III.

Number of hands employed at the mill: Thirty.

Cost of fuel: $20 per day, using coal screenings, 5 tons at $5 per ton. The balance of fuel used was refuse cane, after being dried.

The cost of machinery: Rented the factory at $4,000 per season.

Wages paid for labor: Average wages, $2 per day.

Price of sorghum delivered to mill: Netted $3.50 per ton.

I superintended the planting and raising of the cane at the different farms.

From the 3,600 tons of cane I obtained 54,000 gallons of sirup; at 50 cents per gallon, is $27,000.

Cost of cane	$12,000
Cost of labor	7,200
Rent of factory	4,000
Extra expenses	1,200
Total	24,400
The amount produced by sale of sirup	27,000
Running expenses of factory	24,400
Balance	2,600

The cane during its growth suffered severely from heavy frost.

The results from the 3,600 tons of cane, had the factory been large enough, would, from my experiment, have produced as follows:

From 3,600 tons of cane, 80 pounds of sugar per ton = 288,000 pounds, at 8 cents per pound	$23,040
Amount of sirup remaining, 20,000 gallons, at 30 cents	6,000
	29,040
Less expenses	24,400
Balance	4,640

This would have been the result of the sugar manufactured.

PAUL STECK.

REPORT OF NELSON MALTBY.

GENEVA, OHIO, *January 8, 1883.*

HON. GEORGE B. LORING,
Commissioner of Agriculture, Washington, D. C.:

I have been manufacturing sorghum sirup for many years, and have made many experiments to produce good dry sugar, but never succeeded until the fall of 1881, when I made several small experiments, all of which proved as satisfactory as any which came to my notice in the papers or otherwise. Therefore, when I saw your proposition to the manufacturers of sorghum and other sugar-producing plants, I resolved to put my factory in as perfect condition as my means would admit, believing that, from my past success, I would stand a fair chance to secure one of your rewards. Therefore I expended several hundred dollars erecting a granulating room, granulating vats, defecators, finishing pans, centrifugal, &c. I began to work up cane October 8, and closed November 4; did not run my mill all the time. I worked it eighteen days, making 150 gallons per day. I worked up 17½ acres of cane, all Early Amber except one acre of Early Orange, which I raised from seed sent me from your Department a year ago.

The Orange cane is very strong and stands up well where the Amber will fall down. It yields more sirup, but it is of a darker color. It grains as well as the Amber, but it is about ten days later, but will ripen here. It is a good cane.

I worked up cane from 17½ acres; the weight of the cane was 167 tons and 824 pounds, yielding a little over 9½ tons per acre. I made 1,466 gallons of sirup not to be granulated. I made 1,095 gallons of sirup for sugar, weighing 12 pounds per gallon, all of which grained well. I made 4,380 pounds good dry sugar from the same. From some cane I made 72 pounds sugar and 112 pounds sirup per ton. The average was 62 pounds sugar, 124 pounds sirup per ton. I employed six hands, paying them $1.25 per day each.

Cost of machinery	$3,000 00
Boiler and engine, 55 horse-power	1,500 00
Brick stack for the same, erected last July	320 00
Cane crusher	600 00
Evaporator arch and chimney	260 00
Defecator	50 00
Finishing pans	50 00
Vats, pipes, pumps, &c	120 00
Centrifugal	100 00

The boiler and engine are used for other purposes also. Cost of fuel for boiler and evaporator, $4 per day, most of which can be saved by drying the bagasse a little in the sun, or by piling under cover for a few days, which I tried, when it burned nicely. I used some directly from the grinder, but it does not work so well.

I raised one acre of Amber and one of Orange—the rest I worked up for the farmers of this and the adjoining townships. I charged 20 cents per gallon for manufacturing the sirup, and 25 cents per gallon for that boiled for sugar. I swing the sirup from the sugar, or I take one-half of the sugar and sirup.

The fertilizers used were mostly barnyard manure plowed in. Some used guano in the hill, with good effect on sandy soil; it seems to push the young plant ahead of the weeds in the start. Some used superphosphate, with the same good results on clay soils.

The cane was planted all the way from May 15 to June 10, and began to mature in from one hundred and ten to one hundred and twenty days, according to soil. Cane was very late all through the season, and ripened very unevenly, but two or three lots fully matured.

I regard it of little value as food for cattle, after the juice has been expressed, if the leaves are stripped off before grinding. I think the bagasse worth more for fuel than for fodder. The leaves make excellent fodder. The seeds from several lots that I know of, being thrashed, have yielded from 24 to 33 bushels per acre, clean seed, worth at least from 75 cents to $1 per bushel.

PROCESS OF MANUFACTURE.

I used in most of my operations the process of Prof. F. L. Stewart. The cane is crushed in a heavy iron mill, having three rollers, 24 inches long and 15 inches in diameter. The juice runs from the mill down through a straw filter and is pumped up into a vat holding 200 gallons, from which it is drawn into a heater 2 by 7 feet and 1 foot deep, having 40 feet of copper pipe 1 inch in diameter. The juice is heated by steam to 180° F., then neutralized with milk of lime; the lime is put in until red litmus paper turns blue. The steam is let on until it brings the juice just to a boiling point. The steam is shut off and the scum is removed. As soon as the juice settles, the clear juice is drawn through a swing pipe into a vat where it is treated with sulphurous acid until the blue litmus paper turns red. It is then run through Cook's evaporator (copper, 4 by 15 feet), and boiled to about 30° B. It is then drawn into a steam finishing pan made of pine plank, 2 feet wide and 6 feet long and 1 foot deep, supplied with 35 feet three-fourths inch copper pipe, and boiled to 228° F. for sirup, and to 235° for sugar; then placed in a warm room (from 80° to 100° F.), to granulate, which takes place in from one to six days. I used a fire finishing pan; for a time it worked very well, but not as well as the steam finisher. I regard Cook's evaporator as one of the best fire evaporators in use.

Just before I closed my works I put in a steam evaporator like my finisher, only about double the capacity. I shall double the size of it for next season. It worked much better than any fire evaporator I ever saw. I send sample No. 1.

I have a centrifugal 24 inches in diameter, which I had made at a machine-shop here. I got the wire cloth at the Cleveland Wire Company, where it is made for the planters in the South. It cost $100.

I can swing out 40 or 50 pounds of dry sugar in from eight to twelve minutes. I desired to know whether it would do as good work as those machines that cost much more. The Jefferson Sugar Manufacturing Company of this county have one which cost $400, and as sheir sirup or melada had not granulated yet (their granulating room is so cold, they say), I took some of my mush sugar to their factory and run it through their machine. It works well, but no better than mine.

I made some experiments without acid, defecated with nothing but milk of lime. It requires more care from the operator to get just enough lime and no more, but, with experience and good judgment, this process will give as much sugar as with acid. I send sample No. 2.

It requires some experience to learn just the tinge a proper amount of alkali or acid gives to the litmus paper, with the "Stewart" or any other process.

I made one experiment with sweet corn. I cut 200 pounds of corn-stalks when the ear was just fit for use. It made one gallon of sirup, and from this I obtained 3½ pounds of sugar. It was treated with lime and acid, the same as sorghum. I think I can improve upon this next time. I send sample No. 3.

I also send sample (No. 4) evaporated by fire evaporator (Cook's) and finished by steam. This was made after I had had considerable experience. I have made hundreds of pounds just like it, and can make just as good from all good cane of Amber or Orange variety.

Respectfully,

NELSON MALTBY.

DRUMMOND BRO.'S SORGHUM WORKS.

WARRENSBURG, MO., *October* 28, 1882.

The location of our works is just outside the town limits of Warrensburg, the county seat of Johnson, which lies on or near the 37th parallel of north latitude, and is 200 miles west of Saint Louis.

The number of acres brought to our mill during the past season was 26½, of which 10½ acres were cultivated by ourselves. That brought to our mill by outside parties was of mixed varieties, while that of our own raising was entirely of the three varieties, Early Amber, Orange, and Liberian, cultivated and manufactured separately.

The total number of tons manufactured was 243, being an average of 9⅛ tons per acre. No fertilizers were used, our ground having been in cultivation only two years.

The soil is known as the "hard-water sand land" clay subsoil, high and rolling, with sand-rock substratum.

The earliest planting was that of the Early Amber, from the 20th to the 25th of April. Both the Orange and the Liberian were planted from the 1st to the 5th of May.

The soil was plowed deep and well pulverized with harrow, the planting being done as soon afterward as possible. The seed was drilled in rows running north and south four feet apart, using 3 pounds of the Amber, and 2½ pounds of the Orange and Liberian per acre. The entire crop was cultivated with a double-shovel plow four times, and hoed once.

The first test for saccharine matter was made on August 1, when the Amber showed 6° Baumé. Again on August 9, the Amber tested 8° Baumé, seed in dough; Orange tested same date 3° Baumé, heads in bloom; Liberian heading out same date tested 1° Baumé. We commenced manufacturing sirup from the Amber on August 15; from the Orange on September 19; and from the Liberian on September 30. The Orange and Liberian each tested 10° Baumé at the time of their manufacture.

It will be seen from the above that it took the Amber one hundred and ten days to mature; the Orange one hundred and thirty-five days; and the Liberian one hundred and forty-five days.

The number of pounds of sugar made was 1,464, being an average of 50 pounds per ton of cane.

The Orange and Liberian showed no crystals. The quality of the sugar is equal to the best Louisiana raw sugar. The total amount of sirup manufactured was 3,930 gallons. The following table will serve to group some of the points above, and at the same time afford a limited comparison of the three varieties named:

Varieties.	Planted.	Tests for saccharine matter.			Commenced manufacturing.	Gallons per acre.	Sirup per ton.
		August 1.	August 9.	Data of manufacturing.			
Early Amber	April 20–25	6° Baumé	8° Baumé	10° Baumé	Aug. 15	156	17.0
Orange	May 1–5		3° Baumé	10° Baumé	Sept. 19	160	17.4
Liberian	May 1–5		1° Baumé	10° Baumé	Sept. 30	170	18.5

Varieties.	Total pounds of sugar manufactured.	Pounds of sugar per ton.	Time to mature.	Bushels of seed per acre.	Per cent. of juice obtained.	Weight of sirup per gallon.	No. of tons per acre.
			Days.			Pounds.	
Early Amber	1,464	50	110	10	60	11	Average, 9.6
Orange	No crystals		135	15	60	11	
Liberian	No crystals		145	15	60	11	

We use a heavy two-horse mill, made by Squire Bros., of Buffalo, N. Y., which has a capacity of 75 to 100 gallons juice per hour, and expresses 60 per cent. of the weight of the cane. We use a No. 5 Cook evaporator as a defecator, and a No. 4, *copper bottom*, same make, for finishing. The juice is not *treated*, little or no acid being present, but simply run from the mill into a perforated tin filter, and from there through 100 feet of 1-inch enameled gas-pipe into two tanks near the evaporator. These tanks are made of wood, painted inside and out with red lead and oil, the combined capacity of which is 175 gallons. Each tank is furnished with a swing pipe with a float attachment so arranged as to draw the juice at all times from near the surface, allowing all heavy impurities to settle at the bottom, and to remain until a change of tanks is made, which is usually about every six hours. The flow into the evaporator is regulated by a faucet.

We boil very shallow, about one inch at the receiving end, and about three-fourths of an inch at the finishing end, which is next to the chimney. The evaporation should be done in the shortest possible time. For sirup we boil at 230° F., while for sugar we boil at 234° F.

The sirup is led from the evaporator through a shallow tin trough, as our experience teaches us that the sirup, in order to retain its color and flavor, should be cooled as soon as possible and before entering the storage tank. Where a large quantity o hot sirup is placed at once into the storage tank, it has the effect of injuring both the color and flavor; the latter very frequently by scorching. If the sirup is intended for sugar it should be stored in shallow tanks and kept in a room the temperature o which should be between 80° and 90° F. We use sacks to drain the sirup from the sugar, but think the centrifugal preferable.

At the close of each day's work we clean and wash our mill and all fixtures with lime water, which aids materially in keeping them pure and sweet.

A full set of hands to run the works consists of three men and one half-hand. We work four horses in the mill, one team at a time, changing every six hours. The bagasse is dragged from the mill by the team, using a rope for the purpose. We pay the two hands at the mill $1 each per day; the hand at the evaporator, $2; the half-hand 75 cents, and the team each $1 per day.

We use the best of dry wood for fuel, which costs $3 per cord. We also use a little coal, costing 12½ cents per bushel, making the total cost of fuel per 100 gallons sirup, $3. The entire cost of making will not exceed $300.

We strip our cane while standing in the field, employing boys for this work, who use wooden swords. The cost is $1.50 per acre. After it is stripped we then cut and lay in armfuls, which costs $1 per acre. It is then hauled to the seed yard on a low wagon with a broad frame. The cane is placed lengthwise with the heads hanging over behind, which are cut off with a few blows of a hedge hook, or a heavy corn knife. We then stack on ends under a shed, taking care that it has the proper ventilation, by placing the poles at the top at intervals of not more than 2 or 3 feet. Cane stacked in this manner will keep five or six weeks. The total cost of growing and delivering a good crop of cane at the mill is $11.75 per acre, where the field adjoins the mill. We receive 20 cents per gallon for manufacturing, or one-half the sirup. We sell the sirup at 50 cents per gallon at the works, the cooperage being furnished to us.

The seed is an item worthy of consideration in the cultivation of cane. We believe the seed is worth more than oats for feed, and we make it a practice to cure and save all that we raise. We find sale for a large amount of the seed in the spring of the year selling in quantities at 5 cents per pound, and in smaller lots at about double these rates. What is not thus disposed of we feed to our horses, cattle, hogs, and chickens. It is an excellent flesh-producing food, but not good for milk.

The Early Amber produced 10, and Orange and Liberian each 15, bushels of seed per acre. Bagasse, while not generally used as forage, is considered equally nutritious as straw.

At this date, October 27, we have splendid pasture in the ratoons sprouted from the cane stubble, upon which our stock graze constantly after once becoming used to it. We have never lost any stock from the effects of eating green cane or seed. The ratoons on the Amber cane are now 7 feet high and headed out.

REMARKS.

We have been engaged in raising and manufacturing sorghum for eight years. Have used lime, soda, clay, and bisulphite of lime, but have quit the use of all of them. We think the bisulphite is about the best to use, as it will assist in keeping the mill and vessels sweet, if nothing more. We feed the skimmings and washings to our hogs. We send samples of our sugar and sirup.

DRUMMOND BRO.

REPORT OF A. J. DECKER.

Hon. GEORGE B. LORING,
Commissioner of Agriculture, Washington, D. C.:

I herewith submit to you a report of the work done at my sorghum factory in accordance with specifications in your circular of June 6, 1882.

In making this report I will adhere closely to the practical work, using the expressions commonly used and best understood by the practical worker, leaving the expression of the analyses to the chemist, to whom they properly belong, and if my plain statement of practical results does not merit one of the premiums offered, it may at at least help to establish the fact of the successful working of this industry, and help to make certain and clear some of the points of the process that have been surrounded with doubt and uncertainty; if so, it will be of greater benefit than the amount could be to one individual, and I will be satisfied.

It may be proper to describe the location of my factory and its influence on the work, as well as the season and its influence on the growing of the crop of sorghum cane.

LOCATION.

My factory is located in the city of Fond du Lac, Wis., which is surrounded by low praire land on the east, extending four miles, where an abrupt ledge of lime-stone raises the level of the land about one hundred feet to where the soil is a light clay loam and marl. On the west the black prairie soil extends from one to three miles, when it gradually runs into oak openings, where the soil is mostly clayey, interspersed with small patches of prairie and sandy bottoms near the streams. On the north lies Lake Winnebago, with a strip of sandy meadow land skirting it and extending to the ledge, a distance of less than one mile. On the south the prairie land extends from four to six miles, where it reaches the clay or light loam soil, making the soil within the limit from which most of the cane would naturally grow of what is considered entirely unfit for the raising of cane. Had I understood this fact before I commenced, I would not have located where I did, but it has demonstrated this fact plainly to me, *i. e.*, that while a light sirup may not be made from cane grown on a dark soil, yet its real value is not less than the lighter grades; and this fact is beginning to be understood.

It is much more difficult to make a clear, good-flavored sirup from dark soil, but with good defecators and a good understanding of the juice it can be done with little risk of failure; and while it has been a difficult task to myself, it has helped to widen the field of available locations where success may be attained.

THE SEASON.

The season has been the most unfavorable of any known in this locality since the introduction of this crop. From May 1 to the 25th the thermometer went below 40° every night, and on the 16th and 17th ice formed to the thickness of one-eighth of an inch, and cane that was planted did not come up, or did not grow after it had. The month of June was also very cold, having had frost the 10th, 11th, and 12th, and the cane that did withstand the cold was not more than 5 or 6 inches in height.

The month of July was still generally unfavorable, but some warm days gave the cane a start. August 1 the average fields of cane were not more than a foot high, when it should have been 6 or 8 feet high; but now it began to grow as cane can grow. The more advanced fields grew 3 feet in height in two weeks, and as September came near, hope of having some portion of a crop, which had appeared hopeless, began to revive, and the good weather of September brought the cane forward so rapidly that it seemed that if the weather should be good much of the earliest cane would be ripe enough for sirup by the last part of the month. But on September 22 and 23 there was a sharp frost which killed the leaves of a great many fields of cane, though that planted on high ground almost entirely escaped. After this we had pleasant weather during nearly the entire month of October for our grinding.

The cane was mostly in blossom when the leaves were killed, at which time the juice tested 5° B.; three months later it tested less than 6° B. Whole fields in the same locality that entirely escaped the frost tested an average of 8° B. In some few localities work was done in September, but few commenced before October.

DESCRIPTION OF THE MILL.

The building in which my mill is located is a two-story frame building, 24 by 36 feet, with engine room 20 by 24 feet. Mill room 25 by 25 feet, with shed for storing cane 20 feet wide by 75 feet long, with track running through the center into the mill room beside the mill, the cane being stored on either side of the track and loaded on the car, and run into the mill room as required.

The boiler is a tubular boiler, 48-inch shell, 12 feet long. Forty-nine flues 3 inches in diameter. Smoke stack, 24 inches in diameter and 60 feet high. All put in new. Engine, 20 horse-power, connected with a counter-shaft, on which the pulley that runs the mill is connected. The full capacity of the engine is not required to run the mill, the surplus being for the use of a furniture factory that I have in connection with the sugar works.

MILL.

The mill is a horizontal, three-roll mill, the rolls being 12 inches in diameter, 21 inches long. It is flexible, the amount of pressure being derived from compound screws, upon the ends of which are placed heavy iron pails, into which the desired weight may be placed. I bring my levers so they make a direct pressure on the rolls of about 25,000 pounds, giving by average feeding 6 per cent. of force. The capacity of cane that will test 7° B. is an easy 200 gallons of sirup in ten hours. It was built by the Madison Manufacturing Company, Madison, Wis., and is called the Plantation No. 1; weight, 3,000 pounds; cost, $325.

Under the floor of the mill room I have a small tank holding about 150 gallons of juice, into which the juice runs from the mill, first being strained through wire sieves and straws. From here it is pumped into the defecators.

DEFECATORS.

These are made of galvanized iron 3½ feet by 5 by 2 feet deep, with a coil of 2-inch pipe covering the bottom, passing in at one corner and out at the opposite corner on the same end, the inlet and outlet being made tight with lock nuts, with a globe valve at the inlet and outlet by which the steam is regulated. There are two defecators of this description. While in one a defecation is being made the other is being filled.

THE EVAPORATORS.

There are two, of the following description: These are made of galvanized iron 12 feet long by 4 feet wide and 2 feet deep, with one end slanting at an angle of about 45°, under which is placed a scum trough, with which is connected a 2-inch pipe, which carries the scum into a large tank to be utilized for vinegar. In these evaporators there is a coil of pipe connecting with a 2-inch pipe and decreasing to one inch, where it passes out of the side of the evaporator, aggregating an amount equal to 100 feet. The 2-inch pipe being placed at the inlet, and having the greatest heating power, creates a current to the opposite end, and consequently the scum is carried to the scum trough, where it is skimmed off. With this arrangement one boy usually does the skimming of the two evaporators, as after the first scum is taken off there is but little skimming to be done. In the lowest corner of the evaporator there are two outlets 2 inches in diameter, into which are fitted smooth, round plugs. To one outlet is fitted a swing pipe that may be turned into either of the coolers, of which there are two. The other outlet is fitted with a pipe running outside of the building to run off the water when washing the evaporators. I have used different kinds of valves for the outlet for the sirup, but like the plain round outlet with plugs better, as it gives free access for the sirup to pass off quickly, and leaves no corner to accumulate sediment.

COOLERS.

Coolers are made of plain, square, shallow galvanized-iron tanks with a coil of tin pipe lying on the bottom, through which is pumped a stream of cold water. With these coolers are attached a molasses gate, from which the sirup may be drawn into barrels, and a swing pipe by which it may be drawn into any of the large storage tanks, of which there are enough for the entire crop.

QUALITY OF SOIL.

It has been often stated that black prairie soil was entirely unfit for the raising of sorghum cane. While it is true that sandy land or light clay produces the lightest sirup, it is also true that dark prairie land produces a good quality; which, though not as light in color, is in amount greater. I have made from a single acre of prairie land 320 gallons of good sirup, while the best yield from the sand or clay has been 225 gallons per acre. Though it may be an established fact that light clay or sandy land produces the best quality of sirup, localities where only dark prairie soil is found may not be debarred from producing good results in the manufacture of sirup and sugar.

FERTILIZERS.

The only fertilizers, with an apparent benefit without injuring the quality of the product, are lime and plaster, and these only *one* year; so the conclusions may not hold good; but they would indicate that lime assists in purifying the juice, as that treated with lime in the hill needed but little lime in the defecation, and the use of plaster on the young cane seemed to draw the moisture and help to sustain and keep the young plant thrifty in dry weather.

CULTIVATION.

The ground should be well pulverized and rolled before planting, and should be warm and damp. The seed should not be planted more than one-half inch deep, with the soil well pressed over it. It should be planted in rows running north and south, not nearer than 4 feet, and in hills in the rows 2 feet apart, with not more than six stalks to a hill. As soon as the hills in rows can be seen, work should commence, and the cane be kept perfectly clear until it is 2 feet high, after which it will need but little attention.

HARVESTING.

The best modes now in use are very simple, though expensive, and is a rich field for the inventor. The stripping is done with wooden swords, or cradle fingers, by striking the stalk from top to bottom, leaving them on the ground to be raked up with a horse rake for feed. The seed-tops are cut off and the canes cut and bound in bundles. This is done by piling the cane as fast as cut into a frame "rick" or "saw-horse," and then bound into bundles.

The hauling to the mill is usually done on a rack similar to a wood rack. One cord of cane stalks will weigh about 1½ tons.

STORING AT MILL.

If cane is to be used in a few days it may be piled straight, all one way, to a depth of 8 or 10 feet—if dry when piled. If it is to remain longer it should be piled alternately, crosswise, and protected from sun and rain. For sirup it should be kept a long time. I have had good results from cane kept sixty days after being cut, in both quality and quantity, but if sugar is expected it should be worked immediately, as the sugar deteriorates very fast after cutting and piling.

WORKING AT MILL.

In order to get the best results from the mill it should be fed evenly, the butts of the stalks first, keeping the mill evenly full all the time; and to test the work of the mill, sample lots of cane should be weighed and the bagasse weighed after being run through. Eighty-five per cent. of the stalk being juice it is easy to determine the amount of juice left in the bagasse. My mill gives an average of 60 per cent. of juice in the stalk.

THE DEFECATION.

hTe juice is run from the mill into the juice tank and then pumped into the defecator, which without doubt is the point at which success or failure is determined, especially if sugar is the objective point. The defecator being filled to the desired point, the amount of acid in the juice should be determined by dipping a piece of blue litmus paper in the juice. The acid will turn the color of the paper to a bright pink, the color being clear according to the amount of acid. An amount of well-slaked lime well strained from all coarse particles, equaling one-half pint to each hundred gallons of juice, should be added and well stirred and steam let on. Again try the paper and add lime until the paper is streaked or mottled with blue and pink, thus leaving the juice on the acid side. At this point I think many fail by using too much lime and seeking to overcome the trouble with sulphurous acid or other mixtures. If I, by mistake, get too much lime, I add more raw juice to bring it to the right point. I have used nearly all the prominent processes, and am convinced that common sense well applied, with raw juice, is the surest road to success. If it is run for large works, and sugar is the object, I would recommend sulphurous acid as an equalizer, but not for sirup-making, for the mistakes that would be made would do more harm than good. When this point is settled I heat the juice as fast as possible until the blanket of scum which is formed on the top begins to raise by the pressure of the heat from below, and begins to break and roll, when the steam should be shut off. (If it is allowed to boil violently it dissolves the scum, and the sirup will be cloudy and rank in taste.) Then the juice should be allowed to settle before drawing into the evaporator, which should be done through an opening near the bottom, having on the end of the spout, where it runs into the evaporator, a strainer made of cheese cloth or other fine material to catch any scum or particles that may escape from the defecator. Another outlet should be in the bottom of the defecator at the lowest corner through which to wash out the scum that has settled on the steam coil. This is done by a hose pipe connected with a pump in the engine room. If the defecation has been well done the scum found will be 2 inches or more in thickness and of a streaked copper color, and having a smell similar to baked potatoes, and the juice will be as clear as water, with a slight reddish hue. My judgment is governed much by sight and smell which is acquired by practice and not easily explained. In the first scum that moves on the pan I have become able to tell the quality of soil on which the crop grew. If the defecation is good, the juice, from cane grown on light land, will be as white as milk, with a soft creamy appearance when boiling. The other extreme is cane grown on mucky black land, or on or near a barnyard, which when boiling will be very dark, with large bubbles, presenting a blackish appearance.

Cost of mill.

Building and one acre of land	$1,000 00
Boiler, engine, and fixtures	1,500 00
Cane-mill set up	340 00
Evaporators, defecator, &c	600 00
Belting, pumps, &c	200 00
	3,640 00

Number of hands, their work, and pay.

One man, feeding	$1 50
One man, bringing cane to mill	1 50
One man, engineer	1 50
One boy, hauling bagasse, &c	1 00
One boy, skimming	1 00
Defecator and boiler superintendent	3 00
Fuel, per diem:	
2½ cords pine wood, at $2.50	6 25
Oil and incidentals	25
Interest on investments	66
	16 66
Average sirup per day gallons	150
Amount for making, 20 cents per gallon	$30 00
Profits per day for mill	13 34

The first week's run the cane was very green, the juice testing 5° B.; the average per day being 100 gallons. The second week the test averaged 6° B., and an average of 130 gallons made. The third and fourth weeks much of the juice reached 8° and 9° B., and 200 gallons were made.

Planting.—May 10 to June 1, as soon as the ground is warm enough.

Time of maturing.—From 110 to 120 days.

Fertilizers used.—Slaked lime in the hill, and sand. Plaster on young plants.

Value of bagasse as feed for cattle.—If well cured, after grinding it is about equal to wild hay or oat straw. It is worth more for fuel or paper stock.

Amount of sugar made.—I have swung out a portion of melada that produced 400 pounds of dry sugar—a fraction over one pound to the gallon of sirup, counting the extra crop, aggregating the full amount obtained at 4,000 pounds of a very light yellow with large crystals.

Quality of sirup and sugar.—The sirup is light in color, clear and heavy, and sells at 50 cents, wholesale.

Success of evaporators.—I have two evaporators, each 10 by 4 by 2 feet deep, with a coil of 1½-inch pipe aggregating 100 feet in length, evaporating 100 gallons of water per hour, making 15 gallons of sirup from juice testing 10° B., with steam generated from one-eighth of a cord of wood, costing 30 cents, including power and grinding.

Vacuum pan.—I have no vacuum pan.

Centrifugal.—I have a small centrifugal, 24 inches in diameter, 6 inches deep, with a capacity of 500 pounds per day.

MANUFACTURING.

Number of acres of cane brought to mill	45
Number of tons of cane brought to mill	270
Number of tons per acre	6
Average gallons per ton	14
Highest number of gallons per ton	20
Lowest number of gallons per ton	9
Average saccharine test	6½

The difference in the number of gallons per ton will be easily explained by the following table, which I have carefully calculated, viz:

Juice testing 5° B. takes 18 gallons for one of sirup.

Juice testing 6° B. takes 14 gallons for one of sirup.

Juice testing 7° B. takes 11 gallons for one of sirup.
Juice testing 8° B. takes 8½ gallons for one of sirup.
Juice testing 9° B. takes 7 gallons for one of sirup.
Juice testing 10° B. takes 6 gallons for one of sirup.

The low average of juice-test is owing to the unripe cane, as there was no ripe cane in this locality, and the most of it hardly passed the blossom.

Full amount of sirup made this year	gallons..		3,600
Vinegar	do....		800
(Sugar not yet swung out.)			
Expense of running twenty-four days			$393 84
Received for making 3,600 gallons sirup, at 20 cents		$720 00	
Received for making 800 gallons vinegar		100 00	
			820 00
Profits for twenty-four days			426 16
Average amount per acre	gallons..		80
Amount received per gallon			$0 60

SUGAR.

There are a number of points requisite to the development of sugar from sorghum as well as the process of manufacturing. First, is ripe cane; second, proper appliances; third, "the know how." The long-continued high degree of heat required in open-pan boiling destroys nearly all the sugar long before the required density is reached, and under the most favorable circumstances not more than one pound of sugar to the gallon can be expected from open-pan work, and that does not deserve to be called sugar-making yet. I believe, with the use of the vacuum pan and the skill to run it, sugar in the West is as certain as making flour from wheat.

Respectfully,

A. J. DECKER.

FOND DU LAC, WIS.

REPORT OF WM. FRAZIER.

ESOFEA, VERNON COUNTY, WISCONSIN, *December* 4, 1882.

HON. GEORGE B. LORING,
Commissioner of Agriculture, Washington, D. C.:

DEAR SIR: In compliance with your circular letter of June 6, 1882, I deire to submit the following report:

1. The number of acres of sorghum brought to my mill, including my own, was 41 acres and 29 rods; weight of cane, $258\frac{1915}{2000}$ tons. The number of gallons of juice obtained was 31,339, and the number of gallons of sirup was 3,768. The juice tested from 6° to 10° Baumé. When the juice 6½° Baumé, we estimated 1 gallon of sirup for each 10 gallons of juice; and for each half degree more, one-half gallon less of juice is required to make a gallon of sirup.

In using the annexed table as a basis, our product usually overran our estimates from 2 to 8 gallons in 100. In such cases we plus our estimates accordingly. This rule may not be exactly correct, but we think it nearly so:

Test.	Gallons of juice to one of sirup.
° *B.*	
6½	10
7	9½
7½	9
8	8½
8½	8
9	7½
9½	7
10	6½

The following tabulated statement of the product of the season's work at the factory may be of interest:

Names of patrons.	Acres.	Rods.	Tons.	Pounds.	Gallons of juice.	Test.	Gallons of sirup.
						° *B.*	
Charles Smith	......	24	1	1, 800	180	6½	19
Ole Stovlon	......	10	......	1, 270	70	6½	7
L. Tollakson	......	30	2	650	265	6	25
John Brice	......	20	1	130	150	8	18
S. W. Moore*	......	75	6	900	750	7½	86
P. M. Johnson	......	30	1	900	210	8	23
John Elanson	......	20	1	320	120	6	12
H. Peterson	......	30	1	1, 300	180	6½	18
Martin Stafslien	......	40	3	640	376	6 to 8	41
John Olson	......	6	......	560	35	7	— 4
James S. Anderson*	......	85	7	40	848	7½ to 8	100
Peter Staflien	......	10	......	1, 150	68	8½	8½
Hans Knudson	......	90	6	800	845	7	90
Daniel Isaacson	......	25	2	50	258	6	25½
George Briggs*	1	......	13	325	1, 723	7½ to 9	221
Geary & Nelson	1	......	3	1, 265	445	8	55
John Jacobson	......	20	1	400	138	8	17
John Stevenson*	......	120	8	700	1, 062	7 to 8½	128
T. E. Stevenson*	......	130	7	1, 600	921	8	122
Jacob Johnson	......	15	1	10	108	9	15½
Andrew Enosson	......	24	1	1, 200	195	9	27½
Nels Olson	......	20	1	110	137	8½	18
Christian Johnson	......	60	2	1, 520	630	8	43
Samuel Boyce	......	80	3	860	466	7½	54
Jacob Hogan	......	15	......	1, 540	95	9	13
L. Bolt	......	2	......	170	10	8½	*1
Ole Anderson*	......	60	1	1, 550	208	9½	27
A. Vanruden	......	40	2	1, 220	318	8½	41
William Strey	......	30	1	110	154	8	19
A. B. Saxton	......	20	1	500	134	7½	16
W. S. Frazier*	9	124	55	840	6, 908	7½ to 9	797
Wood & Son*	3	66	32	650	3, 703	7½ to 10	487
William Frazier*	1	......	15	1, 000	1, 946	6 to 6½	190
Do*	19	.....	68	435	7, 974	6 to 10	999
Totals	41	29	258	1, 915	31, 339	6 to 10	3, 768

*S. W. Moore's cane ground was measured, as were also those marked thus (*). The balance of the plats were estimated only, so far as I know.

It may be seen by the table that the average yield of sirup was a little less than 82 gallons per acre; but leaving my 19 acres out, we have an average of about 126 gallons to the acre. But to include it, we got 6 tons of cane per acre, and a little over 14½ gallons of heavy sirup to the ton.

Our land is timbered, mostly oak. Clay soil of pretty good quality. Some of the cane worked was raised on new land, but the larger part was raised on land which had been worked from fifteen to twenty years. Such lands in our locality have generally been seeded to clover three or four times. The new land usually made the finest sirup, especially as to color. I put land plaster on all of my cane last year; am satisfied it materially increased the yield, but I also think it made a darker sirup. I attempted some experiments, during the past season with various fertilizers, but I failed to make any test of their merits as we were overtaken with a heavy frost before we reached that part of the field.

I think the proper time to plant in this latitude is usually from the 10th to the 15th of May. Planted the middle of May, the Early Amber will mature in from ninety-five to one hundred and ten days. The past season was an exception, however, as but little seed matured here this year.

I cured several tons of bagasse; have not had time to experiment as to its actual value, but left a number of cocks in the field where it had been spread to dry. My cattle eat freely of it; at the same time they have access to a stalk-field from which the corn has been gathered. Have fed my horses considerable of it; they prefer it to oat straw, but they will take good hay in preference. I think the stalks are of some value for food. I *know* the blades make *good* feed.

SUGAR HAVING NO CENTRIFUGAL.

My report on this subject cannot be what I would like ; I am able, however, to send you what I believe to be a pretty fair sample of crude sugar ; it was dried from sirup made of Mr. Briggs's cane, dried by draining the sirup through a coarse cloth. Allow me to state here that my object has been sirup, with a view of making sugar in the near future. The most of my sirup was thoroughly grained one week after it was made. Had it granulate in the coolers frequently. My coolers are 8 inches deep and hold 40 gallons each.

On two occasions there was about an inch in the bottom of the second cooler so completely grained that it would not run out, although the melada was quite warm. I now have about 2,500 pounds of sugar in the bottom of sirup-tank, which I intend to throw out in the spring.

I have posts set in the mill yard at convenient distances, with two large holes near the top, into which sticks about 3 feet long are driven; we stand the cane around these posts—several loads may be placed around each one. It is believed this is a much better plan than to pile the cane on the ground. It is certainly more convenient. Every load of cane was carefully weighed and recorded at the time. When it was bound with any coarse material we threw off from 5 to 10 pounds per load. When the blades were not stripped we called 2,200 pounds a ton, but if the blades were well dried a less number of pounds were taken.

My observations lead me to the conclusion that either green or wet blades carry off a much larger per cent. of juice than the dry blades. Let any person who doubts this proposition draw a dry handkerchief across a basin of water and note the result; then slightly moisten the handkerchief and repeat the operation.

PROCESS OF MANUFACTURING.

I use two custom tanks, capacity 180 and 200 gallons respectively, two lime tanks, 150 gallons each, and two tanks for semi-sirup, 100 gallons each. These tanks are made of galvanized iron and wood, and hold just 10 gallons to 1 inch in depth, except those for semi-sirup, which hold 8 gallons to the inch. If it is designed to make a pure speckless sirup, *or especially*, if sugar is sought, these tanks cannot well be dispensed with.

I have 10 feet fall from the mill to the evaporating-house; 4 feet from the level of the evaporator to the floor of the sirup-house. Run my juice through a 2-inch pipe 66 feet, from the mill to the custom tanks. Here the juice is allowed to settle while the tank is being filled. When it is tested, measured, and drawn through a swing-pipe and run into one of the lime tanks, put in enough of the milk of good fresh lime, so the juice will turn blue litmus paper purple. When the lime is put in it must be mixed thoroughly. Of course in process I lime my juice cold.

Some successful manufacturers do their first boiling in batches; this I believe to be unnecessary and inconvenient. I use a pan 17 feet long by 44 inches wide, with three apartments; the one next to the smoke stack is 5 feet long, the next one 4 feet long; the balance of the pan is finished like the Cook evaporator, except that the channels are 16 inches wide.

I run the limed juice into the apartment next to the chimney (this is made separate from balance of pan and placed higher); here it heats gradually, but never boils. We skim this part about once in five or six hours; it passes from this to the second apartment, where it is raised nearly to the boiling point, but not allowed to boil; here it is skimmed every two or three hours. The juice is passed through a gate from this to the third division, almost as clear as water, where it is boiled as rapidly as possible until the green scum is all off, when it is drawn by a continuous flow into one of the semi-sirup tanks, where it is allowed to settle an hour or more from the time it begins to fill until it is empty. Here we obtain a feculency, fine and very tart; these settlings will ferment in a very short time. From these tanks the defecated juice is drawn through swing-pipes into the "Madison" pan (which is really the Cook, No. 7), where it is kept boiling rapidly until finished.

We run the finished sirup by a continuous flow through a wooden trough, covered with fine wire screen, 32 feet to cooler, from one cooler to the other, when it is usually cooled to about 140° F. The second cooler is set on trucks, and when filled it is drawn by means of a windlass and pulleys to the top of the sirup tank, which has a capacity of 2,360 gallons.

A little porous alum water should be used in the semi-sirup; when one of the semi-sirup tanks is about three-fourths full, put in about one pint of alum water, mix thoroughly.

To prepare the alum water, dissolve 2½ pounds of porous alum in ten gallons of water. To prepare the lime, take one-half bushel of good lime, put it into a half barrel or tub of large size, pour on eight or ten pails of hot water, stir well while it is slacking, to keep it from burning; let it stand until it settles; then drain the clear water from the top, mix enough water with the residue to make it about the consistency of thin cream. Usual amount about 1 quart to 80 gallons of juice.

The settling tanks should be rinsed frequently. Each tank should have a large hole in the bottom to expedite the cleansing. On stopping for the day, I always have the mill and all the tanks that are emptied rinsed and whitewashed. The milk of lime should be freely used in or on all places about a sugar factory that are likely to become sour.

Tha woodwork of all tanks, coolers, troughs, &c., used about a sorghum factory, should be thoroughly painted inside and outside with red lead and boiled oil, for obvious reasons. I think the manufacturers of pans and evaporators ought to paint the inside of their woodwork.

I do not filter my cold juice. for the reason that the desired result can be more *surely* accomplished by settling, even when no neutralizing agents are used. But I am so well convinced of the merits of lime that I have no thought of making a gallon of sirup without the use of it, or its equivalent. Any person who has not used settling-tanks will be surprised to find so much dirt and slime in the bottom of their tanks, after drawing the juice from the top by the use of swing-pipes. For the purpose of controlling the flow of the juice from the lime and semi-sirup tanks, I use enlarged wooden faucets inserted in the outlets of the swing-pipes.

The sooner and more rapidly the juice and semi-sirup can be boiled the better, after allowing proper time for subsidence.

That shallow boiling is preferable to deep boiling I have no doubt; I am speaking of fire-trains. We aim to have the juice about an inch deep in all parts of the pans, except in the first two divisions of the defecating pan; in these apartments the depth must be regulated according to circumstances, taking care not to reduce the temperature of the juice to any great extent. If the hot juice is suddenly chilled by an undue rush of cold juice, or if the fire is allowed to cool down, there will of course be a partial precipitation of scum. Under all circumstances a steady hot fire should be kept up.

Too much skimming is bad; any attempt to remove the scum before it becomes somewhat firm—has some body to it—will result in mixing it with the juice, thus materially injuring the quality of the sirup. I believe in the thorough removal of the scum; even the white scum at the finishing end of the pan should all be taken off and put into an open barrel with wire screen cover to keep motes out. A molasses-gate should be put in near the bottom, and when the contents of the barrel have settled, a pretty fair grade of No. 2 sirup may be drawn therefrom. I used wood for fuel; have it split fine for the evaporator, then have a boy whose business it is to keep an even, hot fire, and skim the front end of the pan.

I use an 8 horse-power engine to run the mill. It is a great improvement over animal power. My mill was made by the Madison Manufacturing Company, Madison, Wis. Weight of mill, 3,150 pounds; length of rollers, 21 inches; diameter, 12 inches. The rollers are self-adjusting. The mill does good work.

My buildings consist of one shed, 16 by 30 feet, for boiler, engine, and mill; one defecating and finishing building, placed about 100 feet from the mill. It is one story, inclosed, 24 by 35 feet, having eight doors; and 28 feet from this one sirup house, 16 by 20 feet—entirely too small.

The Cook evaporator makes an excellent finishing-pan if it is preceded by a good defecator. The 17-foot pan, heretofore described, I believe to be one of the best, if not *the* best, defecating-pan in use. Though simple, it cost me much time and study to arrange and construct it, but it has more than met my expectations. Thornby & Ott, of La Crosse, put up and sold a number of them during the past season. I have no pecuniary interest in the manufacture and sale of these pans.

3. The number of hands employed in the factory was seven; the cost of fuel was $1.50 per cord for wood delivered; the cost of machinery, exclusive of buildings, was $1,050; the wages paid for labor was, by the month, from $16 to $18; by the day, from 75 cents to $1.50. I paid $2.50 per ton for cane delivered at the mill; but if the juice tested more than 70° B., then I paid 25 cents more for each degree above 7° B. I bought $87\frac{1490}{2000}$ tons. It tested from 7° to 10° B., and of course it cost from $2.50 to $3.50 per ton.

Cost of running factory one day.

One engineer	$1 00
One man to carry cane to the mill	1 00
One man to feed the mill	75
One man to cart bagasse with hand-carts	75
One man to test and measure juice, attend defecating-pan, &c	1 50
One man to attend the evaporator	1 50
One boy to fire, skim, &c	50
2½ cords of wood, at $1.50 per cord	3 75
Interest on $1,500 investment for, say, thirty days use, per day	4 00
Wear and tear	2 00
Board of seven men	2 00
Lime, &c	25
Total	19 00

CONTRA.

After the first week we averaged about 170 gallons per day of twelve hours, which, at twenty cents per gallon for making, would be $34, thus giving us a profit of $15 per day. Had the juice been as sweet as usual, our credit would have been at least $6 more.

The men who attend the defecating and finishing pans should be careful, observing, industrious, and take an interest in their work. Such men are well worth $1.50 per day, while an indifferent, careless man would be dear at any price.

Actual expense and profit of the season at the factory.

Dr.		Cr.	
To wages of seven men four weeks	$191 75	By making 3,768 gallons of sirup, at 20 cents per gal	$753 60
To wages of one girl to weigh cane	10 00		
To board	56 00		
To fuel	90 00		
To interest on investment	120 00		
To wear and tear	60 00		
To lime, porous alum, &c	7 70		
	535 45		
Balance	218 15		

The profits are not large, but it is certainly encouraging after the gloomy prospects of the past summer, which was the poorest season for sorghum in this locality for many years.

The Early Amber was the only variety of cane raised in this vicinity the past season. While I think it would not be prudent to plant largely of a later variety in this latitude, yet, in order to prolong the working season, I intend to plant a few acres of later kinds next year.

PLANTING AND CULTIVATING.

My ground, which is fair corn land, was put in good order, made smooth with a bunter, lightly marked 3 feet 3⅝ inches each way, making 4,000 hills to the acre. A art of it was planted on the 27th of April, the balance on the 12th and 13th of May; planted the dry seed with corn-planters, about one-half inch deep. But the expected spring rains failed to come. It continued very dry until the 24th day of June, when nearly four inches of rain fell in one day, many heavy rains following, making it impossible to work our crops until the season was far advanced. I replanted my cane twice, but owing to the cold, dry spring and to the ravages of the grub worm, failed to get half a stand on the nineteen-acre piece.

I cultivated my cane four times with sulky corn plows, and hoed it twice. I intend to plant in rows one way next season, putting about 10,000 hills to the acre, and cultivate two or three times with a smoothing harrow.

My sirup is all sold except five barrels that is granulated too much for the groceryman, and about 2,500 pounds of undried sugar. The price obtained per gallon was, wholesale, 52 cents; retail, 60 cents.

I now give you the result of one acre planted on a piece of good land that ought to yield from fifty to sixty bushels of corn:

Preparing ground for planting	$2 00
Planting twice with planters and replanting with hoe	1 00
Cultivating four times with two-horse cultivator	2 00
Hoeing twice	5 00
Stripping, cutting, topping, and hauling to mill	12 40
Use of land	5 00
Actual cost of making 190 gallons, 14 cents per gallon	26 60
Total cost	54 00
We now have a credit of 190 gallons of sirup, worth at the factory	95 00
Expense	54 00
Profit	41 00

The above was planted on a piece of low ground, in rows 3 feet 10 inches apart; hills from 12 to 18 inches apart; the blades were killed on about half of it on the 20th of September. The cane was quite green at the time. It was worked on the 6th and 7th of October. The juice tested only 6° to 6½° B. Had there been a good stand, and the cane ripe, the yield would have been large. The expense per acre of raising and delivering my nineteen-acre piece to the mill was less for the reasons it was planted in check rows; the blades were not stripped, and there was much less cane to handle. It made 999 gallons of sirup, worth $499.50; total cost of production, $360; profit, $139.50.

On the 20th of July I could not have sold my cane at any price.

*Statement of Wood & Son.**

Preparing ground, four and a half days	$9 00
Planting twice with planter	3 00
Cultivating with one horse, two and a half days	3 75
Hoeing, ten days	10 00
Harvesting and delivering to mill	28 00
Use of land, $3\frac{66}{100}$ acres—stumpy	10 00
Total expense	63 75
They receive for their cane	90 10
Expense	63 75
Profit	26 35

Had the seed matured as in previous years, they would have had another profit of at least $25.

I believe the cane seed to be of equal value with corn. I charge one-half the sirup, or 20 cents per gallon, for making. I got but little sirup from my patrons, except I bought the cane. The majority of my patrons were highly pleased; I have not heard a word of complaint from any of them. The only complaint that has come to me in regard to my sirup is that there is too much sugar in it.

The large bottle I send you was drawn from the cooler for a little boy who had raised a few stalks of cane. It being the only small package at hand, that was put up before granulation took place. I also send you a small bottle containing a specimen of my sirup. It was taken from a barrel which was made late in October.

In the foregoing calculations in regard to cost of manufacturing, I have not counted anything for my labor. I took care of the sirup, waited on customers, and, of course, had general supervision of the entire business. The vinegar material obtained and the extra profits of the retail trade paid me well for my time.

All of which is respectfully submitted.

Yours truly,

WM. FRAZIER.

REPORT OF JEFFERSON SUGAR COMPANY.

JEFFERSON, ASHTABULA COUNTY, OHIO,
December 11, 1882.

HON. GEORGE B. LORING,
Commissioner of Agriculture, Washington, D. C.:

SIR: In compliance with the terms of your circular of June 6, I beg leave to submit the following report of the work and success of the Jefferson Sugar Manufacturing Company.

Early in June, 1881, the above company was organized under the corporate laws of Ohio, with an authorized capital stock of $50,000, two-thirds of the stock being subscribed upon the day on which the subscription books were opened. A managing board of five directors was elected. Committees on the erection of buildings and purchase of machinery were appointed. In the mean time, our president and one of our directors had served out an apprenticeship in the factory and laboratory of Prof. F. L. Stewart, the patentee of the celebrated Stewart process of making sugar from cane and corn stalk juices, at Murrysville, Pa.

We did not deem it prudent to invest but a small portion of our capital in sugar machinery or fixtures until the farmers of this vicinity could learn how to grow cane properly for our work, and we also considered it essential that we should demonstrate to the most incredulous of our people that the manufacture of sugar from these plants *was both certain and practicable.* This last condition we have now fulfilled, and as to the other, the education of our farmers, we can report gratifying probabilities. Durng the seasons of 1881 and 1882 we have had over 300 patrons, having done most of our work on shares, and we have given each one of them personally full directions regarding the planting, fertilizing, growing, and harvesting of their crop. We have also given random notices to our papers, infusing into them such directions as were needed from time to time; and in this way we found it most convenient to reach a great many. We commend this to those who are trying to develop a new and promising industry as being essential to its ultimate success. We started a large flouring mill and a saw-mill with a portion of our capital, thereby insuring constant employment of our boiler and engine, and warranting us in getting much more costly and powerful ones than might have been needed for the sugar factory alone. We "builded wiser than we knew," for we have already deserted our first method of defecating and finishing over fires, and now do these most particular parts in large steam pans. Our engineer says that we devour the fog as fast as he can make it.

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* They are careful and accurate in their calculations.

During the sugar season we stop the saw-mill and use all the hands employed there in the sugar factory. In the flouring-mill we grind the cane seed into the most delicious buckwheat flour (?) ever made into griddle cakes, the seed having been carefully cured and thrashed by any wheat thrasher. The three mills are connected to each other and all are run by one boiler and engine—of 75 horse-power each. For the sugar factory we erected a splendid brick building 60 feet square, two stories high, with metal roof. The flouring-mill is 40 by 50 feet, and contains the most approved patterns of milling machinery. Our engine room is 30 by 60 feet, and is situated directly between the sugar factory and flouring-mill. The saw-mill is 30 by 40 feet, and lies directly to the rear of the engine room. The buildings are all neat and substantial, and all have metal roofs. I mention these matters, seemingly foreign to the sugar business, because the constant employment of the power needed for a few weeks in the autumn for the sugar factory is an element of profit and strength to our business worthy of imitation by others who are located in grain and lumber districts.

The entire cost of our sugar outfit, exclusive of the building, including large weighing scales, a No. 1 Louisiana crusher, a 300-gallon defecating pan with steam-coil, three arches and galvanized-iron evaporators, one finishing pan with copper steam-coil, two 250-gallon galvanized-iron tanks for receiving juice from crushers, one 300-gallon copper settling tank for adding solution B (Stewart's patent chemical) in, one centrifugal, an iron retort for the laboratory, and everything else used in connection with the business, cannot exceed $2,000. The capacity of our factory is 30 tons of cane stalks per day, making over 4,000 pounds of sugar and molasses. The season can be prolonged fully ten weeks in this vicinity by the judicious planting of early and late varieties of cane.

The last two seasons have been the most disheartening ones for developing this new industry that our country has seen for years. The months of May and June, for each year, have been cold and wet. In our stiff clay soil it was almost impossible to get the seed of either cane or Indian corn to germinate; and when started it made no growth until late in the summer months. In 1881 it ripened in October, while this year about two-thirds of it did not ripen at all. At least half of this year's product was worked when the seed tufts were in flower, and that, too, when we did not commence work until October and ended November 25. Occasionally a patron's cane that had been better attended to than the average would yield him 10 tons of stalks per acre; from which we unerringly secured for him at least 140 gallons of excellent sirup, or rather molasses, for it weighs about 12 pounds per gallon. We experienced no difficulty in securing by the process under which we work, from matured cane, at least 6 pounds of very white, coarse-grained, sugar per gallon of molasses. So much of the cane was green that most of it was worked up into sirup on shares. We have, therefore, to report, notwithstanding the adverse season, that our factory has succeeded beyond the expectations of its most sanguine friends in securing a good and easy granulation of sugar.

Our experience of the past two years demonstrates to our complete satisfaction that frosts are not so injurious to mature cane as they are to green cane; and further, that it seems to be as easy to secure sugar from frosted cane, if ripe, as from any other. The product of our last day's crushing, November 11, was boiled for sugar on November 25, and the result was just as satisfactory as at any earlier time, and granulated as perfectly. We have not lost a thing by frosts either season, and we had many of them that froze ice quite thick on water. We do not feel sure, however, but that should *hot weather* succeed a frost the effect might be deleterious. Cane might sour under these circumstances. We do our work under the Stewart process, discovered several years ago, and patented under the laws of the United States.

It was our plan to make our large factory serve as a sort of nucleus for a dozen smaller factories, to be located all over the county, at which molasses or melada should be made under the Stewart process and afterwards brought to the central factory for final conversion and separation into sugar. This we shall succeed in doing in this locality.

Several factories were started this season, and all produce the same gratifying results.

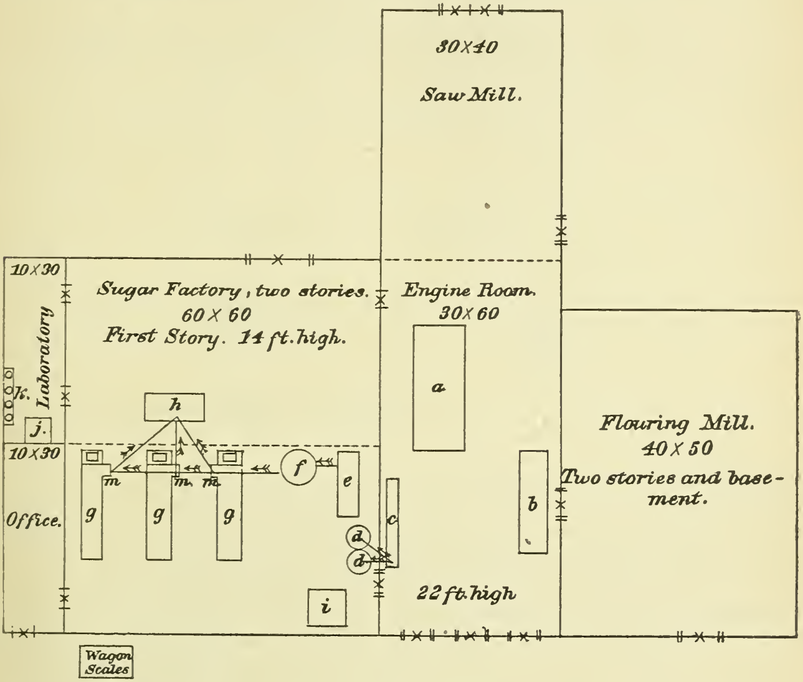
With one exception, no patron has raised more than three-fourths of an acre; therefore your statistical requirements are hard for us to fill in this report. We shall hold our patronage, however, and men who this year planted one-eigth of an acre were so well pleased with our work that many of them have assured us that they will plant from one to five acres next season. Many patrons had so little this year that they had it all made into sirup and paid for making. So generally have they done this that we have not enough left in our factory to make the sugar part of our season's product look very large. In proportion to the quantity boiled into sugar and granulated our showing is more than satisfactory. Our grand success this year will lead us to a far different result next year, as most patrons will want their cane made into sugar. We have provided ample facilities for granulating molasses made at other factories, and for separating their sugar from the sirup. In fact, it makes no difference to us who made it, providing they defecate and prepare the juice properly before cooking it into molasses. We take the sirups and reboil them to a density of 235° F. for sugar, finishing in an open pan by copper steam-coil, and cooking over 500 pounds at once. We may conclude next year to use a vacuum pan for finishing, and save standing it away for several weeks to granulate as at present. Both the Rio Grande and Champaign Sugar Companies use these to complete their work, and probably produce their work cheaper in the end. We cannot cook our sugar as dry in our open pan, but we make as good an article of sugar as either of these companies. It requires more time in our way, but as an offset we urge the small cost for factory fixtures as compared with these companies. We are not yet fully persuaded that the large factories are the greater public benefactors, or that they are pursuing the surest road to the development of this industry to meet the full need of the people. Our method of manufacture is simple and of good and sure results, and what is more important, lies within the reach of every man of moderate means who might desire to engage in it. Any soil or climate that will produce good Indian corn will produce the amber cane needed for this work.

Farmers having maple sugar orchards and proper fixtures, pans, &c., for making this sugar could convert their apparatus into a cane factory at a small expense for crusher and power.

a, is a 75 horse-power wrought-steel boiler; *b*, a 75 horse-power engine of 22-inch stroke; *c*, is a No. 1 Louisiana crusher with table and bagasse carrier; *dd*, are 250-gallon juice tanks with pipes from crusher; *e*, is a 300-gallon galvanized-iron defecating pan with steam-coil for heating; *f*, is a 300-gallon copper tank for receiving juice after it is drawn off from the lime, in which tank the lime is neutralized by the addition of Stewart's solution B. By turning a faucet the juice may be run through pipes, it now being ready for evaporating, into the three evaporators shown in the diagram by letters *g g g*.

In these evaporating or skimming pans the juice is quickly converted into a semi-sirup, and then, by lifting out a wooden plug from the lower corner of the evaporators (*m* in the diagram), the semi-sirup runs into the finishing pan, *h*, where it is finished into a dense molasses for granulation. Before drawing the sirup from the evaporators, *g g g*, the fire is dampened; and in the finishing pan, *h*, it is boiled to a density, by thermometer test, of 235° F. Each man's juice is kept separate in tanks *d d*, until it is measured and tested by saccharometer. The arches, *g g g*, are 3½ feet wide and 15 feet long, with chimneys running up through the granulating room in the second story. We crush out fully 60 per cent. of the weight of the stalks, and this year we burned all of our bagasse, directly from crusher, under the boiler and the three wood arches for the evaporators. We heat the defecating pan, *e*, and finishing pan, *h*, by steam—the former having a ¾-inch gas-pipe coil and the latter an inch copper coil.

Plan of buildings of the Jefferson Sugar Manufacturing Company.



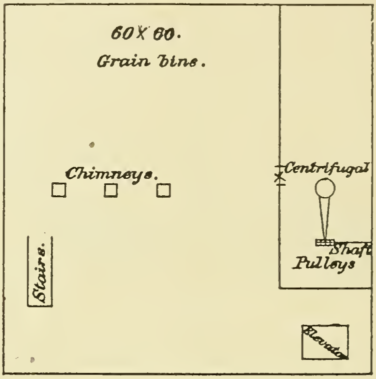
We wash all pans, tanks, &c., once a day, considering cleanliness a virtue in a sugar factory, using a weak solution of lime in so doing. We raise our molasses to the granulating room above on the elevator, *i*. We also use the elevator for hoisting wheat, &c., when the granulating room is used for storing and spreading grain outside of the sugar season. *j* is our chemist's retort, and *k*, the barrels for holding prepared solution B. Doors are represented by *x x x*. The engine *b* is connected to the main shaft of the flouring mill and also by pulleys and shafting to the saw-mill.

We use the large storage room of the second story for granulating the melado in warm weather, and remove what has not fully granulated to the small centrifugal room for further crystallization when winter sets in. We secure three granulations, and get from 6 to 7 pounds of dry sugar to each gallon of molasses. Last year we sold our best drainage molasses for 50 cents per gallon at retail, and our poorest we sold to Mr. Joseph Rhodes, North East, Pa., for 35 cents per gallon. Mr. Rhodes bought a car-load for his large vinegar factory. Our sirup, before granulation, retails at 75 cents per gallon, with a good demand. This sirup we wholesale at 60 cents per gallon, at the mill.

We sell our first granulation of sugar for 8 cents per pound, and cannot supply demand; the second and third granulations sell at 7 cents per pound. The successive granulations keep one man employed until spring.

We worked 190 tons of cane this year, which, it is estimated, was grown on 22 acres of ground. As many of our patrons did not measure the pieces which they planted, we cannot be more accurate. We also worked sweet-corn, common field-corn, and considerable cane for sirup alone, which ought not to show in this report. As before stated, the season was a very unsatisfactory one for growing cane, and but few secured an average crop. The reported yields per acre in tons varied from 4 to 10. With a good season, our general average ought to be increased at least one-third, possibly one-half. The best results were obtained by those who fertilized with superphosphates. The average time of planting was between June 9 and June 12, and many planted over a second time. The exact data, as compiled from the reports of the patrons who could give a date, is as follows: Thirteen planted in May; twenty-eight planted between June 1 and June 8; thirty-nine planted between June 8 and June 15; five planted between June 15 and June 24; two planted later than June 24.

Second story of sugar factory.



We commenced crushing cane October 12, and continued until November 11. Sweet corn was about two weeks earlier. We continued to reboil the semi-sirup until November 25, and consequently have not as yet secured the second and third granulations. The ordinary time of maturity for a cane crop ought not to exceed one hundred days, *i. e.*, for the Amber variety. It did not ripen in four months this year. We do not think the bagasse is of as much value for animal food as for fuel, and consequently burned all of ours. It may possibly be worth more for making paper, but this we have not tried, and will drop the subject with the single suggestion.

We manufactured 33,250 pounds of melado from the 190 tons of cane worked. We have not separated all of it in the centrifugal as yet; but it is running about 4 pounds per gallon (or for every 12 of melado) from the first granulation. We expect on reboiling twice to raise the figures to 7 pounds. Last year we got 6 pounds in every 12 with two boilings from some of the best cane. If we do not succeed in getting more than 6 pounds per gallon we will have from the above figures 16,625 pounds sugar. This would be nearly 90 pounds of sugar per ton of cane, and about 700 pounds per acre of land. We feel assured of this much from the yield of that already separated; but we hope to obtain an average of 7 pounds per gallon from all of the cane worked for sugar during the present season. If cane had fully matured we should not want to stop with less than 8 pounds per gallon.

We send you, by express to-day, samples of our sugar and sirup, which we expect will satisfy your committee of award that a good article of each can be made even on a stiff clay soil. Will soon send Dr. Collier samples of our soil if it will only get warm enough to melt our snow.

Our factory when in full blast requires a night and day set of hands, each set consisting of six men, exclusive of engineer or fireman, as follows: Attending crusher, two men; defecator, one men; for three evaporating-pans, two men; for finishing-pan, making solution B, and adding it in tank *f*, one man. This is a total of six men, and is amply sufficient with our arrangement of apparatus, machinery, &c. The men tending crusher finish in time to clean up tanks for another time. Our wood used in the evaporating arches costs only the expense of cutting and hauling it.

We pay $1.50 per day to those of our hands who do the boiling, &c., and $1.25 to those at the crusher. We have never bought any cane by the ton. If we should, the price would be graded in accordance with the saccharometer test, and would probably range from $2 to $3 per ton.

The cane worked prior to October 18 was not fully mature and only tested 6° to 8° Baumé. This yielded but 12 gallons per ton. From the 18th to the 25th of October it tested from 7° to 10° Baumé with an average of more than 8°; and it yielded 14 gallons per ton. From the 25th to the 31st it tested from 8° to 12° Baumé, with an average above 9°; and yielded 15 gallons per ton. From November 1 to November 11 the test remained about the same; but there was a falling off in the amount of juice expressed, so that the yield was a trifle under 14 gallons per ton. The quality, however, remained about the same. The average yield per ton was 14 gallons, for the season.

The above statements are an accurate transcript from our records, and fairly present the results of our experience for 1882.

A. L. TALCOTT,
Secretary Jefferson Sugar Company.

REPORT OF THE OAK HILL REFINING COMPANY.

EDWARDSVILLE, MADISON COUNTY, ILLINOIS,
December 4, 1882.

HON. GEO. B. LORING, *Commissioner of Agriculture,*
Washington, D. C.:

SIR: In presenting to you, in accordance with your circular of June 6, 1882, our report upon the manufacture of sugar and sirup during the past season, we wish first to explain clearly the objects of our business and its scope and limitations.

The Oak Hill Refining Company was organized in June, 1881, with a capital stock of $5,000. It succeeded to the business of Belcher & Schwarz, and purchased the buildings and entire plant of machinery belonging to that firm, paying for the same in stock.

The business of the previous year (1880–'81) had been a very close one, the profits on a total rolling of 401 tons of cane being only $153.65. In the season of 1881–'82 the profits on a total rolling of 255 tons of cane were $391.73. In the season just closed the amount of cane rolled has been 580 tons and the profits, as nearly as can now be ascertained, are $1,050.

The works of the company are situated about a mile from the city of Edwardsville; the ground in the vicinity is very broken, and the hauling consequently heavy. The original intention of the firm was to run experimentally only, looking to a removal of the machinery and an enlargement in some other locality. When the company was organized, however, it was determined to make the enterprise permanent and as complete as possible for its size. This end we consider has been accomplished, and we tender our report as the report of what has been achieved by the investment of $5,000 in a factory situated in the country, and without adjacent railroads, with disastrous droughts in each of its first three years, receiving in no season more than a quarter of its fair rolling capacity in cane, and yet manufacturing profitably a grade of sirup which has obtained the highest price in the wholesale markets, and establishing an order-trade through the adjacent country (both cities and towns) which dispenses with the necessity of meeting the wholesale prices, and insures in coming seasons very remunerative returns.

MACHINERY EMPLOYED AND METHODS OF MANUFACTURE.

To describe as briefly as possible our machinery and manufacturing methods—

I. The building is a rectangular two-story frame, 28 by 40 feet, standing lengthwise across sloping ground, with a pond on one side and a wagon-road at one end. This end of the building is raised, affording a small third story. From this end also runs a lean-to shed covering the boilers, and above and back of the boilers stands the mill covered by another lean-to, which extends behind the building covering sulphur-box, juice tanks, and clarifiers.

The boilers are two in number, built in one set, each boiler 18 feet long by 48 inches diameter, with five 11-inch flues. They are made of $\frac{5}{16}$-inch iron, and were originally built for ferry-boat use. Grate bars, old style, 4 inches long. Stack sheet-iron 40 inches diameter by 38 feet high above breeching. The furnace has a side entrance (closed by a removable iron door) for stoking bagasse.

The engine is high-pressure, steam cylinder 9 inches diameter, stroke 12 inches, and will give at 80 pounds pressure and 150 revolutions about 20 horse-power. The driving pulley is 42 inches diameter, driving belt 8 inches wide.

The mill is approached by a wide horizontal platform, on which is placed a double track, with an automatic switch just before reaching the mill. This platform runs back some 80 feet, and is made level the whole distance, but owing to the slope of the ground its height diminishes from about 12 inches at the mill to about 2 inches at the other end. Skeleton trucks are used for carrying the cane. The mill itself is one of Blymyer Company's make, No. 3½ (old list), double-geared Niles mill. It has three rollers, each 16 inches diameter by 22 inches long, upper roll flanged. The total weight of mill is from 4 to 5 tons. It is driven by belt, and has an advertised capacity of 300 gallons juice per hour.

From the mill the juice runs to the sulphur box and thence to the juice tanks. The sulphur fumes, before reaching the box, pass over a water trough, thus preventing the transmission of any sulphuric acid.

The juice tanks are three in number, each 3 by 4 feet by 30 inches deep; total capacity of the three is between 600 and 700 gallons juice.

From these tanks the clarifiers are filled by direct connections. The "clarifiers" (or "defecators," as generally termed in the Northern factories) are two in number, each 3 by 4 feet by 30 inches deep, with wooden troughs on each side for holding the scum. The heat is applied by a 1½-inch steam-coil at the bottom of the clarifier, having double entrance and exit through the bottom. The coils lie about 2½ inches above the bottom, thus affording an opportunity for washing out the sediment after the clarified juice has been drawn off.

From the clarifiers the juice runs to the settling tanks, three in number; and from them, by means of a monte-jus, it is elevated to a receiving tank in the top of the building.

The evaporator is circular, 5 feet in diameter by 30 inches deep, with a flaring brim at the top terminating on one side in a trough about 6 inches deep. The whole vessel is of solid copper, and the steam is applied by two copper worms lying close to the bottom and having their entrances and exits through the bottom; the total length of worm is about 110 feet.

Two semi-sirup tanks afford opportunity for settling still further, and for the stor age of unfinished sirup. The "strike-pan" (or "finishing pan") is similar to the evaporator, except in being smaller (only 4 feet in diameter) and having no scum-trough. The total length of worm is only about 90 feet. (We must here say that our evaporator and strike-pan were both made in New Orleans, and with no instructions, excepting to give us the style most approved by the Southern sugar manufacturers.) The finished sirup is cooled in our factory by running it through a wooden trough around the sides of a room containing sirup tanks. The windows of the room were protected by wire-gauze screens so as to keep out insects and dirt of all kinds, while allowing a free passage of air.

The centrifugal machine which we use was made by A. Fesca, of Berlin. It is underdriven, and has no bottom-discharge. The diameter of basket is 36 inches, being larger than the Weston hanging machines so much used in this country, in which the basket is only 30 inches diameter.

Our centrifugal has a capacity of about 400 pounds melada at a charge, which, if the goods are not too gummy, will be dried in fifteen to twenty minutes.

II. So much in outline as descriptive of the machinery we have used. Our process of working has been extremely simple. To begin at the beginning: Each load of cane when received was weighed on an ordinary wagon scale, and the check given for it could be cashed at any time. From the scale the cane was taken to the platform and unloaded from the wagon directly upon the trucks if possible, or if not, upon the platform alongside of the trucks. The trucks carried from 1,000 to 1,200 pounds of cane, and one man could handle a loaded truck without difficulty. Two men were ample for the platform work. Our mill was run at a speed of about 20 feet per minute, and fed as uniformly as possible, the best results being obtained from a rather heavy, but unvarying, feed. With a driving pully 42 inches in diameter, we had very little trouble in belt-slippage. To obviate the great annoyance of the finely-crushed bagasse choking the mill, we stationed a boy behind the mill to clear away the bagasse from the rolls. The bagasse-carrier traveled forward and upward over the boilers, delivering the bagasse by a shoot on the ground alongside of the boilers. The juice from the mill passed through a long perforated screen before reaching the sulphur-box. The fragments of cane and pithy matter that were separated by this screen contained considerable juice.

In large works (rolling, say, upwards of a hundred tons a day) a strainer, like the "feed squeezers" in glucose factories, but smaller, would probably pay. The length of the water trough over which we passed the sulphur fumes before using them was 8 feet. As small a quantity of sulphur as practicable was kept burning; it was, of course, necessary that it should not burn entirely out. We did not delay before clarifying.

While sulphured juice will keep for some time, there is probably nothing gained by it. A little sediment forms in cold juice, but the same and much more will be precipitated in the clarification.

The foamy scum on the surface of fresh juice need not be removed unless it interferes with the operator. Of course, at least once in twelve hours (twice is better) the juice tanks ought to be thoroughly cleaned and washed with lime-water.

Clarification, the "bugbear" of so many, is really quite simple in principle. The criterion is the *clarification*, *not* the *decolorization* of the juice. The lime used should be of uniform strength, or the operator may be misled. A solution of about 12° Baumé is in common use; a thick paste of lime is also used; it matters not which, provided regularity be enforced. In liming the juice (which we prefer to do before heating) the operator should be careful to add less than enough lime for neutralizing the acidity; litmus paper will show this. After the clarification is completed, the juice ought to be bright, nearly transparent between the flocks of gummy precipitate which have been formed.

(A bottle on the end of a stick or a test-tube will answer for sampling the juice.) If the sample is bright, enough lime has been added; try the next clarifier with a little less. If not bright, however, add a little more in the next clarifier.

Continue trying until the point is reached, viz, just enough lime, and no more, to "clarify" the juice. Each clarifier, through the entire run of the season, will be more or less experimental; but a good operator, after finding his "points," will not vary rashly, and by watching the cane carefully can keep a pretty uniform clarification.

In clarification we raise the first scum very slowly, getting as thick a "blanket" as possible before skimming; then raise another if any more scum appears; then boil briskly for a few moments, and then allow to settle before drawing off.

We have used, and with considerable advantage, a little superphosphate of lime about a pint in 100 gallons of juice. With this reagent, we obtain a brighter-colored and better-flavored syrup than with the sulphur fumes alone; we add it to the cold juice, before liming. It is largely used in the South and in the West Indies.

As to settling tanks, we find them of great service. In the Louisiana plan of working, where the clarifiers are numerous, the settling is done in them; but the Northern works are limited in expensive machinery. A tank or two between the clarifiers and evaporator is very useful, as we can hurry along the well-clarified juice, leaving any cloudy or muddy portions to take their time in settling.

We use a monte-jus for elevating juice and find it perfectly satisfactory in every way. It is cheaper than a pump, works without any spilling of juice, and delivers very quickly. We would not recommend it for semi-sirup or sirup, as it might darken the color if allowed to remain charged too long. The style of evaporator which we have used we can recommend heartily, for it has given us entire satisfaction.

The evaporation of thin liquids, which at different temperatures cast up scum of different characters, cannot probably be perfectly done in closed vessels, like triple-effect vacuum pans, for instance; though, theoretically, these are more economical, and are well adapted for purified liquids, such as thin glucose solutions, or boneblack-filtered beet juice. On heating up the juice in our evaporator there first arises a thin green scum, which must be carefully removed with a copper skimmer; then as the temperature rises the mass breaks into a foam and rises to the brim of the pan. By properly adjusting the steam-valve, it is held just at this point, so that the scum-bubbles can be lightly swept over the flat side into the trough by a wooden sword, These bubbles of scum *must be swept off* before clotting into large flakes, as the ebullition of the juice tends to carry them under and mingle them hopelessly with the boiling mass; any excess of juice swept over into the scum-trough can always be drawn off again, after settling into the next batch of juice.

When the foaming surface shows no more clots of scum, the batch of juice is "clean": the steam is lowered till the liquid settles down in the pan; then a full head of steam is suddenly turned on and the boiling down begins. This boiling is usually continued until the juice has attained a density of 20° to 25° B. (hot); 25° B. is better if the "semi-sirup" is to remain some days before finishing. High-pressure steam, 80 pounds is necessary when the boiling down begins, otherwise the juice, instead of breaking into active ebullition, will foam upwards and overflow the pan. Upon the care and diligence of the operator in sweeping the juice will depend the brightness and purity of the sirup. The time required for sweeping a charge is anywhere from fifteen to thirty minutes—with good cane juice, well clarified, it should not exceed fifteen minutes; the boiling-down, with high steam, will require from fifteen to twenty minutes.

Finishing the sirup in the strike-pan is similar to the boiling-down in the evaporator. Often, however, a gentle heating and skimming may be advantageous before turning on full steam.

The time of finishing should be less than ten minutes. We finished our sirup at 35° to 36° B. (hot). We have obtained good results by settling the semi-sirup, but if it has been well swept in the evaporator we would prefer to finish without delay. When semi-sirup has been cooled, and requires to be heated up again in the strike-pan, there is a loss of time and fuel, and the sirup is darkened by being so much longer exposed to steam heat.

A rapid cooling of the finished sirup is important always, and to expose it in thin streams to the air is about as practicable a method as we know of. If collected in bulk in tanks before cooling, caramelization will result, sometimes to an astonishing degree. Even semi-sirup will darken and caramelize, as we have learned by experience. We did not fit up a "hot-room" for the purpose of promoting the granulation of sugar. Such a room, where a temperature of 90° to 110° F. can be uniformly maintained, is necessary to obtain any reliable results in sugar manufacture. The little use we have made of our centrifugal perhaps does not require a report, but we can say that it has a capacity for easily doing the following work, viz: 800 pounds good melada every half hour, or 8,000 pounds in ten hours' running time.

And now we must state plainly that we have not manufactured sugar *on a business scale* this season. That is, we have simply made a small quantity as samples of our work, and contented ourselves with turning out the greater part of our products as sirup. We did this for several reasons.

In the first place, during the two previous years the juice, at its best (and seldom so), had been on the ragged edge; that is, scarcely enough sugar to crystallize under the most favorable circumstances. In 1880-'81 the best "quotient of purity" (*i. e.* polarization divided by solid contents) was about equal to the lowest boilings in a sugar refinery, where a vacuum pan is needed, and three weeks' storage in a "hot room" to insure a yield of 25 per cent. in sugar, and afterwards a bone-black filtration to give the sirup a salable color. In 1881-'82 the cane, if anything, was poorer; we had fine looking, ripe cane, the stalks of which were sticky with exuded juice; it had been in the society of the chinch-bug, and the juice polarized from 1 to 2 per cent. This year the chinch-bug had been hard at work, improving the time as far as possible; and we knew what to expect.

Secondly, we had added this season, at considerable expense, boiling capacity for an expected crop which we did not realize; we had not fitted up apparatus for bone-black filtration or vacuum boiling; we had a large demand, at good prices, for our sirup, with the certainty that in the following season sirups, with cheap cane, must rule low. So we made our business a sirup business, and it has been a profitable one We do not, of course, presume to offer an opinion as to the comparative profits of manufacturing sugar and sirup from sorghum cane, excepting so far as the prices obtained have actuated *our enterprise.* We do maintain that with our limited storage room for melado, our lack of apparatus for bone-black filtration and vacuum boiling, and, above all, the necessity for turning over our active means as rapidly as possible—with these features in our business, we maintain that sirup seling readily at 50 cents per gallon pays us better than sugar at 8 cents per pound (with this proviso: that only one crystallization is to be had, for if the sirup from the melada can be again crystallized there is no question but that the industry should be a business of *sugar*, not of *sirup*, manufacture).

As a justification of our opinion we submit the following figures: One gallon sirup (if pure sugar in water) weighing 11.50 pounds contains 8.55 pounds sugar and 2.95 pounds water; this equals 74.35 per cent. sugar and 25.65 per cent. water. For easy figuring, we will say 25 per cent. water. One pound melada should contain 12 per cent. water; the difference is lost in evaporation. Then we have: 11.50 pounds sirup (containing 25 per cent. water) will reduce to 87 per cent. of 11.50 pounds, or 10.005 pounds melada. Then 1 gallon sirup = 50 cents; or 11.50 pounds, at 4.35 cents per pound. If boiled down for sugar and swung out, we have—

1. BEST PROBABLE RESULT.

	Cents.
10 pounds melada, 40 per cent. sugar, 4 pounds, at 8 cents	32. 00
(Sirup after boiling down) 55 per cent. sirup, 5.50 pounds, at 4.35 cents	23. 92
	55. 92

This result would certainly require bone-black filtration and a vacuum pan, otherwise the last sirup would be much poorer.

2. A PROBABLE RESULT.

	Cents.
10 pounds melada, 30 per cent. sugar, 3 pounds, at 8 cents	24.00
(Sirup after boiling down) 65 per cent. sirup, 6.50 pounds, at 4.35 cents.	28.28
	52.28

These percentages are not poor in refinery practice, and they ought not to be deemed so in factories.

The prices still require bone-black, &c.

3. A POSSIBLE RESULT (WITHOUT BONE-BLACK).

	Cents.
10 pounds melada, 30 per cent. sugar, 3 pounds at 7.50 cents	22.50
(Sirup after boiling down) 65 per cent. sirup, 6.50 pounds, at 3.50 cents.	22.75
	45.25

In none of these estimates have we considered the cost of swinging out the sugar and reboiling the sirup. We simply wish to show the narrow margin between sugar and sirup manufacture, when sirups are high in price, and only one crystallization can be obtained. With regard to fuel, we will say that we have burned the bagasse direct from the mill without previously drying it. It was not convenient to do the latter, owing to the situation of the building and the irregularity of the ground. Certainly dried bagasse is better fuel and (we judge without personal experience) more economical. It would have cost as much to have hauled away our bagasse as to have burned it; so we burned it. About 50 bushels of coal and three-quarters of a cord of wood per day sufficed, with bagasse, to maintain high steam (80 pounds) and to boil away the water from 300 gallons of juice per hour, besides running engine, mill, pumps, &c.

We did not attempt to feed the bagasse to stock, and doubt its practicability. The scum from our factory we did not utilize. This is an important item in the economy of a sorghum factory, and another year will receive due attention.

In closing this report we must express our regret at its length, but it is difficult to intelligibly describe, by words only, any manufacturing operations. For answers, as far as we can give them, to further questions suggested by your topics, we refer to the appended tabular statement and our report upon "cultivation and harvesting."

For the purpose of exhibiting more clearly the results we have obtained, we have also forwarded a case of samples, which are taken from barrels and tanks in our ordinary run of work, and are not especially selected, excepting as to difference in the varieties of cane rolled at different times during the season.

Can No. 1 contains sirup made from juice of the Early Amber.

Can No. 2 contains sirup made from juice of the Orange.

Can No. 3 contains sirup made from juice of the Liberian.

Can No. 4 contains sirup made from juice of the Honduras.

Can No. 5* contains sirup made from juice of the Orange.

One can contains sugar from Amber and Orange cane.

Affidavits covering our reports and samples are also appended.

Hoping that by these papers we have fully met the requirements of your circular of June 6, 1882, we have the honor to subscribe ourselves, sir, with great respect, your most obedient servants,

THE OAK HILL REFINING COMPANY.
GEO. C. W. BELCHER, *President.*

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* This sirup was filtered through a sand filter before finishing; the difference in character is not appreciable.

TABULAR STATEMENTS.

I.—*Yields and products.*

Total cane received .... 580 tons.
Of which .... 444 tons from 151 acres planted.

Balance .... 136 tons from 40 acres planted (estimated).

Total acreage .... 191 (partly estimated).
Cane per acre, a little over 3 tons.

Total cane received:

Early amber	pounds	235,403
Orange	do	721,940
Stewart's Hybrid	do	18,090
Liberian	do	43,080
Honduras	do	141,800
		1,160,313 = 580 tons 313 pounds.

Total gallons juice expressed	60,350
Of which the Liberian gave	2,100

Density of juice, 10° B. (highest) to 6½° B. (lowest).

Gallons juice per ton:

Liberian*	97.493
Other varieties	104.274
All cane included	104.024

	Gallons.
Total sirup manufactured	8,150
Sirup per ton of cane	14.05
Gallons juice per gallon sirup	7.405

II.—*Costs.*

We paid for cane $3 per ton. The cane was to be well stripped and topped, and to be delivered in good condition at the factory. A few loads of unstripped cane were received by special agreement, but 10 per cent. was deducted from the weight when aid for.

	Cents per gallon.
The raw material, therefore, cost us $3 ÷ 14.05 gallons	21.352
Cost of manufacture (ledger accounts to date and unpaid bills carefully estimated)	15.222
Total cost of sirup	36.574

Principal items of cost of working were as follows:

	Cents per gallon.
Fuel	1.983
Expense (insurance, rent, taxes, &c.)	1.581
Labor	6.910
Cooperage	1.751
Drayage	.342

The amount of fuel used by us was 1,510$\frac{50}{80}$ bushels coal and 25½ cords wood. The wood cost us $2 per cord, and the coal from 6½ to 7½ cents per bushel, delivered at the factory.

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*This cane lay on ground until dry; an unfair trial.

The following hands were employed in the factory:

	Per day.
One engineer	$2 00
One fireman	1 50
Two cane-carriers	1 25
One mill-feeder	1 50
One boy at mill	50
One man at clarifier	1 50
One man at evaporator	2 00
One man weighing cane and coopering, &c	2 00

Total, 9 hands; total wages, $13.50 per day.

The cost of the principal portions of our machinery is as follows:

Mill (in place and ready for work)	$800
Evaporator (in place and ready for work)	500
Strike-pan (in place and ready for work)	350
Clarifiers (in place and ready for work)	150
Boilers (in place and ready for work)	1,600
Engine and pumps (in place and ready for work)	600
	4,000

Cultivation and Harvesting.

VARIETY OF CANE PLANTED.

Early Amber, Hybrid, Early Orange, Kansas Orange, Liberian, and Honduras.

TIME OF PLANTING.

From the 18th day of March to 1st day of June, but the best time in this latitude is from April 1 to May 15.

PREPARATION OF SOIL, PLANTING, AND CULTIVATION.

One plowing, the same as for corn; then harrow down well, and if soil is very dry, also roll smooth.

For planting we have found the common 8-hoe wheat drill the best implement, by covering up all the feed holes but two (the second from each side) and setting it to one peck, as for wheat. It will then drill from 3 to 4 pounds per acre, making the rows 40 inches apart. The hoes should be well set back, so as to drill as shallow as possible.

When the cane is sprouted and just before it comes through the surface, the harrow is used again if the soil is not too wet; this destroys the weeds then just ready to grow, and gives the cane a chance to get well ahead for the plow or cultivator. When fairly up it is thinned out by using the wheat drill and cultivating with it crosswise, *i. e.*, at right angles to the rows. This has also the advantage of a cross-cultivation, and in favorable weather saves the expense of hand-hoeing. After this from one to two cultivations with a two-horse walking cultivator is sufficient to finish it, as it should not be worked after it reaches four feet in height.

The above mode has been found to be the most successful in twenty years' experience.

Cane should never be planted in a furrow like corn, but drilled on the surface like wheat. Another great advantage of the wheat drill is that the small furrows made on each side of the planted rows keep the seed drained and prevent washing out on the hill-sides.

The best soil for the Early Amber cane is a sandy loam, bottom land; for Orange cane and other late varieties we prefer a clay soil, slightly sandy, either upland or timber land.

The land being comparatively new in this section, fertilizers have not been used here, with the exception of barn-yard manure, which, however, has a bad effect on the cane, causing too rank a growth and poor juice. The past three years the chinch-bugs have been very troublesome in this section wherever wheat is grown to any extent. They have done great damage to the cane crop, especially severe in dry seasons, as the past three have been.

HARVESTING.

The stripping was done mostly by boys, who were paid at the rate of $2 per acre. When the leaves were saved for fodder they were stripped by hand and put between the stalks to dry for one day and then bound into bundles; otherwise they were beaten off by laths.

The cutting and topping was done at one operation in the field, paying men $1.25 per day without board, or at the rate of $2 per acre.

The hauling to the mill has cost for a distance less than a mile 40 cents per ton, for a mile 50 cents per ton, and for a mile and a half 60 cents per ton.

TIME OF MATURING.

Cane planted in this latitude on the 1st of May will mature ready for rolling as follows:

Early Amber, August 15.
Stewart's Hybrid, August 20 to September 1.
Early and Kansas Orange, September 1 to September 15.
Liberian, September 15 to October 1.
Honduras, October 15.

Averaging cost of cultivation and harvesting, we would get as follows:

	Per acre.	
Planting and cultivation:		
Rent of ground	$3 00	
Plowing and harrowing	2 50	
Rolling and drilling	50	
Harrowing cane	25	
Cross-cultivation with drill	30	
Two-horse cultivator (twice)	70	
In extreme cases, one hoeing	1 50	
		$8 75
Harvesting:	Per acre.	
Stripping	2 00	
Cutting and topping	2 00	
Hauling 4¼ tons	2 12½	
		6 12½
		14 87½
4¼ tons cane, at $3		12 75
Loss		2 12½
Seed (at rate of 2 bushels to the ton), 8½ bushels, at 50 cents		4 25
Profit		2 12½

This estimate is based on a yield of 4¼ tons per acre. The fodder, although worth about $1 per cwt., and averaging about 100 pounds per ton of cane, is not taken in consideration, as it is very difficult in the rush of the season to save it all. Last year it was nearly all saved, and hay being scarce the leaves were sold at the rate of $1.40 per cwt.

The crops raised in this vicinity were very small indeed, and not remunerative to the planter, e. *g.*:

One planting 20 acres, 71½ tons, average 3½ tons.
One planting 60 acres, 178½ tons, average 3 tons.
One planting 45 acres, 84 tons, average 2 tons.
One planting 26 acres, 110 tons, average 4¼ tons.

The last named was planted by Mr. C. M. Schwarz, and formed the basis of the above estimate of costs, &c. In this planting the Early Amber averaged 5 tons per acre; Orange averaged 5.1 tons per acre; Kansas Orange averaged 3 tons per acre; Honduras averaged 3.6 tons per acre.

The late varieties having suffered more from the chinch-bug than the Amber cane, accounts for the low yield which under equal conditions would be from one-quarter to one-third more than the Amber. The chinch-bug seems to have at last disappeared, and it is to be hoped that they will not trouble us for years to come. Sugar cannot be made in paying quantities during their stay, nor more than half a crop of cane realized, with the best of care.

Our seed has not been thrashed yet, but it is good and will not fall below the average of two bushels per ton of cane. It has been tried for two seasons in fattening hogs, and for that purpose is fully equal to corn.

TABULATED STATEMENT.

Each manufacturer is requested to submit an account of his work to this Department, covering the following points, viz:

1. *a.* "An accurate account of the number of acres brought to his mill": 71½ tons from 20 acres; 178½ tons from 60 acres; 84 tons from 45 acres; 110 tons from 26 acres; total, 444 tons from 151 acres; balance, 136 tons from 40 acres (estimated); total, 580 tons from 191 acres.

b. "The number of tons of cane manufactured": 580 tons and 313 pounds.

c. "The yield of sorghum per acre": A little more than three tons per acre on all the planting; some portions of course much more; one or two small pieces of ground yielded more than ten tons per acre.

d. "The mode of fertilizing": Fertilizers were not used.

e. "The time of planting": From the 18th day of March up to the 1st day of June.

f. "The time required for maturing the plant": According to the variety of cane, from three and one-half months to five and one-half months.

g. "And the value of the crop as food for cattle after the juice has been expressed": We did not use the bagasse for stock-feeding.

2. *a.* "The amount of sugar manufactured": Only a small quantity up to date has been dried in the centrifugal; considerable remains in our tanks, but cannot estimate accurately.

b. "The amount yielded per ton of cane."

c. "The quality of the sugar."

d "The amount of sirup manufactured": 8,150 gallons.

e. "The process of manufacturing."

f. "The machinery used."

g. "The success of the evaporator, the vacuum-pan, and the centrifugal in the work of manufacturing": We have no vacuum-pan; our evaporator and centrifugal gave us perfect satisfaction.

3. *a.* "The number of hands employed in the mill": Nine, all told, for a regular day's work of ten hours' rolling.

b. "The cost of fuel": Wood, $2 per cord delivered at factory; coal, from 6¼ to 10¼ cents per bushel delivered at factory; cost of fuel per gallon sirup manufactured was 1.983 cents.

c. "The cost of machinery."

d. "The wages paid for labor": For men's labor, from $1.25 to $2 per day; boys, 50 cents per day.

e. "And the price of sorghum at the mill if not raised by the manufacturer": $3 per ton for well stripped and topped cane delivered at the mill in good condition.

GEO. C. W. BELCHER,
President Oak Hill Sugar Refining Company.

C. BOZARTH, STEAM SORGHUM WORKS.

CEDAR FALLS, IOWA, *November* 25, 1882,

HON. G. B. LORING,
Commissioner of Agriculture, Washington, D. C.:

I herewith submit my report of this year's work on sorghum cane crop. I want to preface by stating that I have been in the business twenty-four years, and this has been the worst year for cane that we have had for sixteen years. We had a very cold, wet, backward spring. The cane was four weeks coming up; after which there were a number of hard frosts, the weather continuing cold and wet up to July, which so delayed the crop that it was not much past the bloom when frost came again on the 22d of September, leaving the cane poor in sweetness and weight, both marking only 6° to 8° Baumé, and averaging not more than 7°. I have made but little sugar this season; hardly enough to pay for running through the centrifugal machine; and inasmuch as the sirup is a good price I have not thought best to put it through for the little that is in it; although there is a considerable granulation through all my sirup—fully as much this year as I could expect, and more, considering the quality of cane. Last year I had 5,000 pounds that sold in the market for 8½ cents per pound, and the year before 15,000 pounds that sold for 8 cents per pound. I raised this year on my own farm 85 acres, which was all worked without stripping. I give the Dr. and Cr. below.

DR.

To use of 85 acres, at $2.50	$212 50
To plowing and dragging 85 acres, at $1.50 per acre	127 50
To five days' man and team and boy planting	15 00
To cultivating three times, $1 per acre	85 00
To sixty days' hand-hoeing, at $1.25 per day	75 00
To six bushels seed, my own raising	6 00
To sixty-four days' cutting, at $1.50 per day	96 00
To four teams hauling, sixteen days each, at $2.50 per day	160 00
To four hands at mill for sixteen days, at $1.50 per day	96 00
To one fireman, sixteen days, at $1.50 per day	24 00
To one engineer, sixteen days, at $2.50 per day	40 00
To three hands at evaporators, at $1.50 each per day	72 00
To 5 cords wood per day for sixteen days, at $3.50	280 00
Total	1,289 00

Yield of sirup from 85 acres, 9,860 gallons, which sold for 50 cents per gallon, wholesale; and 15 barrels vinegar from skimming, worth $6 per barrel.

CR.

By 9,860 gallons sirup, sold at 50 cents	$4,930 00
By 15 barrels vinegar, at $6	90 00
Total value of crop	5,020 00
Deduct $1,289, the cost of crop and manufacturing	1,289 00
Leaves net balance of	3,731 00

The yield was 700 tons, an average of 8⅛ tons to the acre.

Cost of cane delivered at mill, $1.11; cost per gallon to manufacture after cane is delivered to mill, 5⅕ cents: net profit per acre, $43.76.

On a good crop that yields 10 tons to the acre or more, it can be delivered at the mill for 85 or 90 cents per ton, and if it marks 10° Baumé, as it generally does, it can be manufactured into sirup at a cost of 4 cents per gallon, and sugar at a cost of 2 cents per pound.

My mill extracted an average of 55 per cent. of juice from the cane, making a fraction over 14 gallons to the ton of cane. I have not made a complete success of burning bagasse yet, but think I will another year and make a large saving in the fuel bill.

In addition to the foregoing, I worked of cane raised by my neighbors 292 tons, making 4,060 gallons of sirup which stands me a fraction less than 14 gallons to the ton. The following is the cost:

DR.

Four men at mill for seven days, at $1.50 each	$42 00
One fireman seven days, at $1.50 per day	10 50
One engineer seven days, at $2.50 per day	17 50
Three men at evaporators seven days, at $1.50 each per day	31 50
5 cords wood per day, 35 cords, at $3.50	122 50
Total cost of manufacturing 4,060 gallons sirup, cost per gallon to manufacture 5½ cents	224 00

I worked it all on shares, getting one-half, which gave me 2,030 gallons, at a net cost of 11 cents per gallon, which is worth at wholesale		$1,015 00
Deduct cost of manufacture		224 00
Leaves balance for seven days' work of		791 00
	$1,289 00	
	224 00	
Total expense of year's work	1,513 00	
Proceeds from sirup sold, 11,890 gallons, at 50 cents		5,945 00
Deduct expense of		1,513 00
Leaves balance for year's work of		4,432 00

In the foregoing calculation you observe I have made no allowance for interest on cost of machinery, nor for the seed heads and fodder. Although not ripe enough to save for seed, I have had fifty head of cattle and horses running in the cane field for fifty days, and they have done well with no other feed, and there is feed for some time yet. I think the fodder and feed is equal to the interest on machinery. From my experience I think it safe to say that nine years in ten it will yield 20 to 25 bushels of seed to the acre that will weigh, when clean, from 56 to 58 pounds to the bushel, worth almost, or quite as much, as corn to feed. My mill and large steam coil was manufactured by George L. Squier & Brother, of Buffalo, N. Y.

Cost of Louisiana No. 2 mill	$1,050
Cost of large steam coil	250
Cost of small coil made in Dubuque	100
Cost of engine and boiler made by Skinner & Wood, Erie, Pa	800
Cost of large boiler and a hand for coils made in Chicago	550
Cost of centrifugal made by J. A. Hedges, of Saint Louis, Mo	85
Total cash outlay for machinery	2,835

I have done by my own labor and that of hired hands all my own building and setting up machinery. I cannot give exact cost, but think it safe to say that $800 will cover cost of buildings and sirup tank, six in number. This makes the cost of my outfit $3,635.

My mill has a capacity of about 5 tons per hour, and my evaporators have a capacity of 60 gallons of sirup per hour on juice that will mark 10° sweet. In my work this year the mill ran from ten to eleven hours per day, and evaporators about fourteen hours per day. It would be economy to run night and day.

Now a word about the crop, and I will close. It is as sure a crop as dent corn, yielding, with good cultivation, from 10 to 12 tons per acre, and about 20 bushels of seed, which is worth nearly as much as corn, and more than oats to feed. All kinds of farm stock eat it and grow fat on it. For milch cows, when ground, it is a superior feed to almost any other kind of grain, giving large yield of milk and butter of fine quality. All kinds of fowls prefer it to other grain. Horses grow fat on it fed either ground or in sheaf. When well cleaned through smutter and ground into flour it makes just as good pancakes as buckwheat. The bagasse is a very superior mulching for orchard or other trees, and all shrubbery that needs a mulch. It is an excellent absorbent and bedding for both horses and cattle in stables, superior to other straw, making large quantities of the best of manure; and for bedding hogs it is the best material I ever saw, making them look as clean as though they were curried and brushed every morning. For covering and banking sheds for stock it is better by far than straw. Where it is spread out upon the fields and burned it is made immediately available, being equal to a coat of barnyard manure. Fine crops of grain can be grown on the same field from year to year without rotation. It does not seem to take the fertility from the soil as much as other crops. It leaves a very large amount of roots and stubble in and on the ground, which soon decay and leave the ground in fine condition for other crops. There is no other field crop raised in the West that pays as well or as sure as the cane crop when well managed. A good crop will give from 40 to 50 per cent. better crop and profit than this year. I have a good demand and home market for all I make, generally selling out in about three months. Wherever a sorghum factory is established and makes good sirup, they soon run out the glucose sirup, and the sugar gives universal satisfaction wherever brown sugar is used. Since writing first report, I have shown bagasse to paper mill at Cedar Falls, and they think it would make as good paper as straw, but they have not tried it as yet, as straw is plenty. The vinegar from the skimmings is of the best quality; much better than that generally in market. With sufficient storage tanks for skimmings, I should have made 100 barrels this year instead of 15.

Respectfully submitted by—

CLINTON BOZARTH,
Cedar Falls, Black Hawk County, Iowa.

NOTE.—I never have experimented with sorghum for fodder for stock sufficiently to know certainly its relative value to other fodder—such as corn fodder and hay; but have noticed for years when any cane is left in piles around the mill that is damaged by frost or so immature as not to be worth grinding is always eaten up clean by the cattle and colts before spring. The colts will stand and paw it out of snow a foot deep by the hour as long as there is any to be found; and also when the bagasse is sufficiently dried not to heat in the piles, the cattle eat of it considerably; and in absence of other cheap feed I don't know why farmers could not make a cheap and good food for stock by the ensilage process, of which I have no practical knowledge.

Very truly,

CLINTON BOZARTH.

CULTIVATION OF THE BEET.

SOIL.

A deep friable loam is the most suitable soil for growing sugar beets. Cold, damp, and alkaline soils are unsuitable. All lands that are free from alkali and do not become hard during the summer months have been found to be profitable in this climate for growing sugar beets.

PREPARING THE SOIL.

The planting season commences on the high lands as early as March, and ends on the lower lands in the latter part of May.

As early in the season as practicable the land is plowed from twelve to sixteen inches deep, harrowed, and allowed to remain undisturbed till the vegetation plowed under has decayed. A second plowing, which should not be over four or five inches deep, is then necessary. After this the surface is thoroughly pulverized and rolled. If the rainy season be over, seeding is deferred from ten to twelve days. Seed sown on freshly plowed soil will germinate immediately. Should the weather then become warm and dry, the moisture will recede from the surface, the germs die, and the seed be lost. It is a fact peculiar to this climate that after the rainy season is over little or no rain falls till the next winter, the moisture necessary for plant life rising to the surface from below.

SEEDING.

The seeding is done by means of a drill, made especially for this purpose, sowing five rows, 15 inches apart, at a time. To insure a good stand of beets, upon which depends the success of the crop, from 12 to 15 pounds of seed is sown to the acre. Transplanting rootlets from thickly grown places to barren spots has proven a failure.

THINNING.

Thinning should be proceeded with as soon as the beets are fairly up. Beets allowed to stand too long before thinning receive a set back during that operation from which they never fully recover, and a short crop is the result. From 4 to 6 inches apart is the proper distance for thinning. Experience has taught us that close planting is the most profitable for both the farmer and the manufacturer. Beets grown closely will grow entirely under the ground, be richer, yield a greater weight per acre, and be less exhausting to the soil.

HARVESTING.

The beets first sown become ripe as early as the middle of August. At this period the beets are frequently polarized, and only the ripest fields allowed to be harvested.

The most popular method of digging the beet is by means of a plow that greatly resembles a subsoil plow with the mole-board and share taken off, leaving only the standard and plow-point to go into the ground. This arrangement loosens the beets without bruising or exposing them to the sun or frost. The leaves are severed by hand, with one blow of the knife, which necessitates leaving the green neck of the beet adhering to them, which, with the leaves, is left on the ground to decay, and its constituents to go back into the soil. The climate being so mild here silotting is dispensed with. The excess of beets not required for the day's run is placed adjacent to the factory in long triangular piles about 5 feet high and 8 feet wide, and covered with straw to be taken to the factory when required by means of a car running on a tramway.

ESTIMATING THE VALUE OF THE BEET.

The value of the beet for sugar-making purposes is shown by the percentage of sugar it contains as compared with its sugar quotient or coefficient of purity. In order to ascertain the percentage of sugar and the sugar quotient, an analysis is necessary, which may be made quickly and with adequate exactness by means of a polariscope and a saccharometer, and is done as follows: The beets are grated to a fine pulp, and the juice expressed. Its density is found by means of a Brix or a Balling saccharometer, which indicates directly the percentage of solid matter in the juice. The percentage of sugar is determined by the polariscope. The sugar quotient is that portion of the solid matter which is sugar.

EXAMPLE.

A juice contains 15 per cent. of solid matter, and has 12 per cent. of sugar. Then 80 per cent. of the solid matter ($\frac{12}{15}=80$ per cent.) is sugar, and is what is termed the sugar quotient. Beets with less than 8 per cent. of sugar, and with a sugar quotient of less than 75 per cent., would not be profitable to manufacture into sugar in this country. Several authors have written tables giving the value of beets according to the specific gravity of the juice. The practical sugar-maker can readily see the fallacy of such statements.

MANUFACTURE.

There being so many machines for producing the same effect, each having individual merit, and so much now being written in the English language describing them, that it is not necessary to give them more than passing mention. However, I would say that the vacuum-pans, condensers, evaporators, filters, revivifying kilns, centrifugals, pumps, and engines manufactured in the United States are equal to, and, in many cases, far superior to those made in Europe.

WASHING.

The washer consists of a square wooden tank in which is placed a perforated wooden cylinder 3½ feet in diameter and 9 feet long, so as to be about one-third submerged in water, a stream of which is constantly flowing into the tank. One end of the cylinder is open for the introduction of the roots. To the other end is fitted an iron head with two opposite apertures, so fitted with perforated iron flanges as to eject the washed beets, and by means of suitable gearing the whole is caused to revolve about thirty times a minute.

SLICING.

The roots are carried by means of an endless chain elevator to a hopper, directly under which is situated the slicer. The slicer consists of a vertical iron cylinder about 2 feet deep, in which is situated a closely fitting cast-iron disc, containing eight sets of knives, which reduce the beets to long V-shaped strips about one-fourth of an inch wide. This style of knife is preferable to the kind cutting the rectangular cossettes, for it increases the capacity of the slicer, and is much more easily kept in order. The thinner the slices are cut, the more easily are they diffused. The cossettes run directly from the slicer through a chute to the diffuser.

DIFFUSION BATTERY.

The diffusion process is conceded to be the best method of extracting saccharine matter from beets. There are several forms of diffusion batteries, of which the Circular Ridd Battery is the most efficacious. It should consist of at least twelve diffusers, and the same number of heaters, which are arranged alternately with the diffusers, the whole plant being arranged in a circle. Each diffuser is provided with a man-hole on the top for admitting the cossettes, and a man-hole on the bottom for discharging the exhausted cossettes. These diffuses are connected together by means of pipes, that pass from the bottom of one to the heater, and from the upper part of the heater to the top of the next diffuser. They are also provided with a series of pipes, one of which admits the water pressure, and the other conveys the juice to the defecating-pans. Any one of the diffusers being filled with cossettes, water is caused to pass through the contiguous heater, its temperature raised to 65° C. (149° F.), and allowed to flow into the diffuser as rapidly as that temperature can be maintained, till the diffuser is full, when the upper man-hole is closed, and the steam and air that has accumulated allowed to escape by means of a valve situated at the uppermost part of the diffuser for that purpose. The hot water coming in contact with the cosettes kills the protoplasmic membranous walls of the sugar cells, forming them into excellent dialysers, when an interchanging immediately takes place between the water and the saccharine matter in the cells, and continues till their concentration is equal. As this osmosis only takes place between crystallizable bodies, the colloid or non-crystallizable substances are left in the cells. Care, therefore, should be taken that the temperature be not allowed to go too high, as it would cause the cells to burst. The diffuser filled, having been allowed to stand for three minutes, water, at the temperature of 65° C., is admitted, forcing the liquid it contains through the next heater, where its temperature is raised to 65° C., and is allowed to flow into the next diffuser, which has previously been filled with fresh cossettes. It being full, it is allowed to stand three minutes, when the next diffuser is filled in the same manner This procedure is followed till eight diffusers are filled, when the liquid in the eighth having become sufficiently concentrated is delivered to the pans. The ninth one is then filled, when the water pressure is changed to the second diffuser, and the entire contents of the first diffuser filled, which has become exhausted of saccharine matter is discharged; thus, at all times not having more than eight diffusions filled at a time. When each subsequent one is filled, its first menstruum is sent to the defecating-pans.

DEFECATION OF THE JUICE.

The juice, on arriving at the defecation-pans, has a temperature of about 30° C. (86° F.) From 2 to 3 per cent. of lime mixed to a thin paste is added (the exact amount of lime to add depends upon the quality of the juice, and can only be ascertained by actual trial) and thoroughly mixed, when the carbonic acid is admitted, and the temperature gradually raised to 80° C. (176° F.) At this period it has a great tendency to froth, which is arrested by adding a small quantity of oil or parafine. The progress of saturation is noted from time to time by taking a small quantity in a ladle. When the saturation is complete, a flocculent precipitate rapidly falls, leaving a layer of clear juice on top. The flow of carbonic acid is then checked, and the juice brought to ebullition. A valve at the bottom of the pan is then opened which permits the entire contents of the pan to pass into a monte-jus, from which it is forced through a filter-press; the precipitate is separated from the clear juice, which flows into the carbonation-pans. The action of the lime is very complex and not definitely understood. It enters into combination with any free acids that may exist in the juice, combines with gum and casein, and forms the fatty substances into insoluble lime soap. The salts, soda, potash, and magnesia, which were combined with acids, are liberated, while the excess of lime combines with sugar forming sucrate of lime, which is decomposed by carbonic acid, liberating the sugar, and forming the lime into carbonate of lime.

CARBONATION-PANS.

Here a small quantity of lime is added (about one-half of 1 per cent. of milk of lime weighing 20° Baumé) to destroy matters which resisted the first liming. The temperature is raised to 80° C. (176° F.), and carbonic acid admitted. The saturation is never carried so far as to remove all of the lime, for a certain amount is necessary for the preservation of the juice. The juice is then forced by means of a monte-jus through a second filter-press.

MANUFACTURE OF CARBONIC ACID.

The carbonic acid is made by burning coke in a closed furnace, the gases being drawn away by means of a pump which forces them through the washer, and delivers the carbonic acid gas, comparatively pure, to the carbonation pans. At most factories the carbonic acid is obtained from continuous lime-kilns. We have found the above the most economical for us.

FILTER-PRESS.

The filter-presses we have in use are a modification of "Trink's press." Their purpose is to separate the scums from the clear juice. Two sets are required, one set for for the first and one set for the second carbonation. The former are required to be cleaned about once every two hours, and the cloths in them changed and washed each twelve hours. The latter are not cleaned oftener than once each twelve hours.

FILTRATION THROUGH ANIMAL CHARCOAL.

Although the previous operations have eliminated the most of the impurities, there still remains a considerable quantity, principally potash, soda, magnesia, albumen, and coloring matter, which cannot be entirely removed, but may, to a great extent, by means of animal charcoal ("char"), which is placed in "closed filters" three feet in diameter and twenty feet long, and are so connected that the juice may be forced over two or more filters, thus increasing the height of coal over which the juice has to pass. A filter having been filled with "char" is filled with water, which is allowed to run off, and steam passed through for three-quarters of an hour, when the filter is ready for use. It is then filled with the clarified juice from the "presses," technically known as "thin juice," which is allowed to pass over the "char" till it becomes turbid, when it is forced over onto a second "filter" by means of hot water, which is termed "overrunning." The hot water is allowed to pass through it till no trace of sugar remains. This is termed "sweetening off." The "sweet water" thus obtained is passed with the thin juice to the triple effect, where it is evaporated till it weighs 25° Baumé, when it is termed "thick juice." The "thick juice" is passed over two "filters" till it becomes discolored, when it is overrun onto a third filter, and the first filter is "sweetened off." The filtered "thick juice" is then passed to storage tanks to be boiled in vacuo.

REVIVIFICATION OF ANIMAL CHAR.

The "char" may be used from eight to twelve hours before its absorbing powers have become exhausted, when it is removed from the filter and placed in wooden tanks, where it is treated with hydrochloric acid, which changes the insoluble carbonate of lime into chloride of lime, which is soluble, and causes the vegetable and albuminous matters to decay.

The per cent. of carbonate of lime in the "char" may be determined by Scheibler's calcimeter; although not very exact, it is sufficiently accurate for all practical purposes. Scheibler also gives a table showing the amount of acid to use for each per cent. of carbonate of lime found in the "char." Practical experience, however, is a better guide. It may be roughly stated that about 20 pounds of commercial hydrochloric acid should be used for each 100 pounds of carbonate of lime found in excess of the normal amount, which may be placed at 7 per cent. The "char" having been treated with acid is allowed to ferment at least eight days. It is removed, washed, and heated to redness in the revivifying kiln, when it is again ready for use. Only the best "char" is used for filtering the thick juice. "Char" unfit for filtering the "thick juice" is used for the "thin juice." The "thick" and "thin juice chars" are scrupulously kept separate. Separate fermenting tanks, washers, and revivifying kilns are necessary.

MANAGEMENT OF THE VACUUM PAN.

Boiling to grain.—The air pump is started, and as soon as the vacuum has reached 25 inches the juice valve is opened and juice admitted to cover the first steam-coil, steam is turned on, and the juice rapidly concentrated, fresh juice being admitted to replace the evaporation. This is continued to the granulating point, which is easily recognized by a white streak running through a "proof" taken at this time. Fresh juice is then admitted till a "proof" taken will flow quickly from the fingers. The mass is again concentrated, until the white streak is shown in the "proof"; juice is then admitted to a thin "proof." By this time with good juice, 22° to 24° Beaumé, a fine grain will have appeared, which must be fed from time to time with fresh juice till the pan is full, when the mass is boiled to a thick "proof" and emptied into coolers. In boiling good juice the grain forms very quickly; but with poor juice from sour beets the greatest judgment is required to form the grain, it sometimes not appearing before the seventh or eighth draw.

Boiling blank proof.—In boiling blank the juice is concentrated till a proof taken between the thumb and finger will draw to a thread from one to two inches long. The sirup is then drawn off into coolers, where it granulates. The first products are boiled to granulation, and the after products are boiled blank.

Centrifugals.—The cooled mass from the vacuum pan is placed in the mixer, where, by means of revolving arms, it is reduced to a soft, pulpy consistency. It is then placed into the centrifugals, which revolve from 1,000 to 1,200 times a minute, and a fine spray of water is passed onto the crystals, driving the last traces of sirup off. The machines are then stopped and their contents placed in a Hersey drier, from which the sugar is packed into barrels ready for the market. The sirup from this product is again boiled, and the sugar obtained dissolved with the "thin juice." The third and fourth products are refined by themselves.

LIST OF MACHINERY.

1 Ridd diffusion battery; capacity, 100 tons.
1 beet-washer; capacity, 100 tons.
1 beet-slicer; capacity, 100 tons.
4 clarifying pans.
4 carbonation pans.
7 monte-jus.
7 filter presses.
12 bone-coal filters.
1 triple-effect evaporator.
1 vacuum pan, 9 tons capacity.
6 centrifugals.
1 Hersey drier.
1 Montague cube machine.
1 60 horse-power engine.
1 45 horse-power engine.
1 45 horse-power beam engine.
1 No. 8 Hooker pump.
2 No. 6 Hooker pumps.
1 No. 5 Cameron vacuum pump.
7 external fire, flue boilers, 56 inches in diameter and 16 feet long.